INSTALLATION MANUAL

LOVECO-4V

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1.0 General recommendations

- Before installing the gas system, disconnect the battery earth cable (unless specified to the contrary by the car maker).

  Attention: this may delete the car radio and telephone memories and jam the centralised door locking and anti-theft systems. In this case, you may connect the battery temporarily.
- Always smooth holes after drilling and apply anti-rust to the edges.
- Apply silicon to each cable through-hole to prevent water from entering the interior.
- Install the control unit as far away as possible from areas where water could infiltrate, far away from heat sources (e.g.: exhaust manifolds), far away from high-voltage cables and, wherever possible, with the connector pointing downwards.
- If the fuse blows, do not replace it with one of a higher current rating.
- Do not attempt to open the control unit as this could cause irreparable damage. LOVATO declines all liability for injury to people or damage to property should its equipment be tampered with. In this event the warranty shall also be invalidated.
- Always make electrical connections using the relative joints or soft solder them to prevent the formation of false contacts.
- Always observe the current laws and/or regulations in the State where the LPG system is mounted.
- Remember that, as per the relative standards, all the assembly instructions refer to the driving position.
- Before mounting the electronic control unit, make sure the relative fuses are disconnected.
- Do not wash the engine after installation.

WARNING

FAILURE TO OBSERVE THE INSTRUCTIONS CONTAINED IN THIS MANUAL MAY CAUSE THE SYSTEM TO WORK INCORRECTLY OR NOT WORK AT ALL. THIS MAY CAUSE DAMAGE TO LOVATO COMPONENTS AND INVALIDATE THE WARRANTY.

2.0 Characteristics of the aspirated system for Loveco 4EU catalytic injection vehicles

2.1 System description

Aspirated systems for catalytic injection vehicles comprise:

- Filling valve
- Tank
- Tank valve
- Safety solenoid valves
- Pressure reducer
- Flow actuator
- Mixer
- Compressed air connections
- Electronic carburation control unit
- Petrol injector emulation control unit
- Wiring harnesses
- Switch

2.2 Operating principle

LPG The liquid LPG is stored in equilibrium with the vapour phase in a tank fitted with a multivalve. Storage pressure depends on the composition and temperature of the fuel. The LPG is collected in its liquid phase and delivered to the reducer/vaporiser along the pressurised piping to which the LPG solenoid valve is fitted. The reducer/vaporiser is heated by the engine cooling water, vaporises the fuel and adjusts its pressure to a constant value ranging from 0.5 to 1.0 depending on the model of reducer. The gaseous LPG reaches the engine through the mixer on the throttle body. The LPG is batched by the negative pressure generated by the venturi tubes in the mixer which, thanks to the increase in air speed caused by an obstruction, generates a depression that sucks in the quantity of gas from the pressure reducer proportionally to the aperture of the accelerator throttle, mixing it with the air required by the engine.
For carburation to be as close as possible to the optimal stoichiometric ratio, the lambda probe generates an electrical signal and sends it to the LOVECO 4EU control unit which processes it and sends a signal to a flow actuator located on the hose connecting the reducer to the mixer.

NATURAL GAS The natural gas is stored in the tank. Storage pressure depends on the composition and temperature of the fuel. The natural gas is collected in its gaseous phase and delivered to the pressure reducer along the pressurised piping to which the CUT-OFF valve is fitted. The pressure reducer, heated by the engine cooling water, adjusts the pressure to a constant value ranging from 0.5 to 1.0 depending on the model of reducer. The natural gas reaches the engine through the mixer on the throttle body. The natural gas is batched by the negative pressure generated by the venturi tubes in the mixer which, thanks to the increase in air speed caused by an obstruction, generates a depression that sucks in the quantity of gas from the pressure reducer proportionally to the aperture of the accelerator throttle, mixing it with the air required by the engine.
For carburation to be as close as possible to the optimal stoichiometric ratio, the lambda probe generates an electrical signal and sends it to the LOVECO 4EU control unit which processes it and sends a signal to a flow actuator located on the hose connecting the reducer to the mixer.

2.3 Precautions for fitters

- The Loveco 4EU kit may be installed on cars with engine capacities ranging from 890 to 2480 cm^3.

WARNING

MAKE SURE THE ELECTRONIC PETROL INJECTION MANAGEMENT SYSTEM, ESPECIALLY THE LAMBDA PROBE, IS IN PERFECT WORKING ORDER; ANY IRREGULARITIES OR FAULTS MAY BE TRANSFERRED TO THE GAS INJECTION SYSTEM AND CAUSE IT TO WORK INCORRECTLY.

- Check the general condition of the car.
- Check the signals required for conversion, especially the Lambda probe.
- Follow the instructions in this manual with care.

3.0 Aspirated system components

Aspirated systems for catalytic injection vehicles comprise the following components:

- Filling valve
- Tank
- Multivalve (cylinder valve on natural gas systems)
- LPG solenoid valve (CUT-OFF valve for natural gas systems)
- Electronic reducer complete with certificate of guarantee
- Reducer fixing bracket
- Accessory bag
- Length of water rubber hose 15x23 (7x13 for natural gas systems)
- Length of rubber hose E67R1-110 19x27
- Length of high-pressure hose 4x6 in a roll
- Injector emulator complete with wiring harness
- Mixer
- Loveco 4EU carburation control unit
- Injector emulator control unit
- LOVECO 4EU wiring harness
- Switch
- Wiring harness for Loveco 4EU switch

3.1 Description of parts

LPG solenoid valve (CUT-OFF valve)

This electromagnetic device interrupts the flow of LPG (natural gas) when the engine is stopped or when the fuel supply is switched to the petrol mode.

Reducer / vaporiser (Pressure reducer)

The reducer / vaporiser provides the heat required to vaporise the liquid LPG from the tank and reduces and adjusts the pressure of the LPG in its gaseous phase. It is complete with a lock-off solenoid valve for interrupting the flow of LPG when the engine is stopped or when the car is fuelled by petrol and an idle screw for adjusting the quantity of gas while the engine is idling. This component can be fitted with a temperature sensor for the petrol / LPG switching procedure, only when the engine temperature is higher than 25°C.

The pressure reducer provides the heat required to warm up the natural gas from the tank and reduces and adjusts its pressure. It is complete with a cut-off solenoid valve for interrupting the flow of natural gas when the engine is stopped or when the car is fuelled by petrol and an idle screw for adjusting the quantity of gas while the engine is idling. This component can be fitted with a temperature sensor for the petrol / natural gas switching procedure, only when the engine temperature is higher than 25°C.

LPG accessory bag

The accessory bag contains the clamps, connectors, fuse holders with relative fuses, screws and hardware required to install the KIT.

Rubber hosing

There are four types of rubber hosing in the Kit:

- water circuit hosing for heating the reducer/vaporiser with the fluid in the engine cooling circuit.

- E67R1-110R0 is a hose measuring 19x27, approved pursuant to European Regulations E67- R01 and 110R00, that connects the reducer to the actuator and the actuator to the mixer.

- coil of copper (steel for natural gas) piping for compressed air connections between the multivalve (filling valve for natural gas) of the tank and the LPG lock-off solenoid valve (CUT-OFF solenoid valve for natural gas) in the engine compartment and between the solenoid valve and the reducer.

Mixer

This releases the correct quantity of the air-gas mixture in proportion to the effective request for air from the engine, as determined by the aperture of the accelerator throttle. Its shape and size depend on the characteristics of the car being converted to LPG or natural gas.

Flow actuator

The flow actuator adjusts the GAS/air mixture. Depending on the signal from the lambda probe, processed by the electronic control unit, the stepper motor moves the flow limiting device, thereby increasing or decreasing the flow of gas from the outlet connector. This ensures that the value of the GAS/air mixture will remain close to Lambda 1

Loveco 4EU electronic control unit

This microprocessor-controlled electronic system processes the signals from the sensors, lambda probe and TPS in real time and relays them to the flow actuator which modifies carburation to maintain an optimal air-gas ratio for correct engine and catalyser operation.

LOVECO 4EU wiring harness

The universal wiring harness supplied with the LOVECO 4EU Kit connects the electronic LPG sensor to the sensors required to determine the operating conditions of the engine and the system components.

Wiring harness for Loveco 4EU switch

The Loveco 4EU switch harness connects the switch to the control unit.

Injector cutter control unit

This control unit prevents the petrol injection system from working while the engine is running in the gas mode.

Emulator wiring harness

This wiring harness connects the injector cutter control unit to the individual petrol injectors in order to interrupt the petrol mode. Dedicated Bosch and Japan wiring harnesses are available.

Switch

This electronic device allows the driver to switch the fuel supply from petrol to gas (and vice-versa) and to view the operating status and gas level in the tank.
For further information on the switch please consult chapter 8.0 User information and the use and maintenance manual.

4.0 Installation sequence

The sequence of operations for installing the system is shown below.

1 Installing the tank, multivalve of cylinder valve and high pressure line to the engine compartment (Consult the specific manual for each product)
2 Locating the installation area for the Reducer/Vaporiser or pressure reducer
3 Locating the installation area for the LPG solenoid valve or the CUT-OFF solenoid valve,
4 Installing the LPG solenoid valve or the CUT-OFF solenoid valve,
5 Installing the reducer/vaporiser or pressure reducer,
6 Installing the mixer
7 Installing the carburation control unit and the injector emulator control unit
8 Installing the switch
9 Electrical connections
10 Calibration
11 Diagnostics
12 Road test

Before starting to mount the components, the areas where the devices can be installed inside the engine compartment must be located according to the following instructions.

4.1 Locating the installation area for the Reducer/Vaporiser

Fix the reducer/vaporiser (pressure reducer) to the car with the relative steel support, making sure to observe the following requirements:

- The reducer must be mounted as indicated in figure 1.
- the gas outlet must point towards the mixer at a fairly close distance
- the reducer must be fed with engine cooling fluid through the hose connectors
- the reducer must be positioned so that it can be easily accessed from above after assembly; it must also be easy to reach the idle screw and read its serial number during its MOT test
- after making all compressed air, hydraulic and electrical connections, the reducer must not touch or lie dangerously close to moving or hot parts of the car.

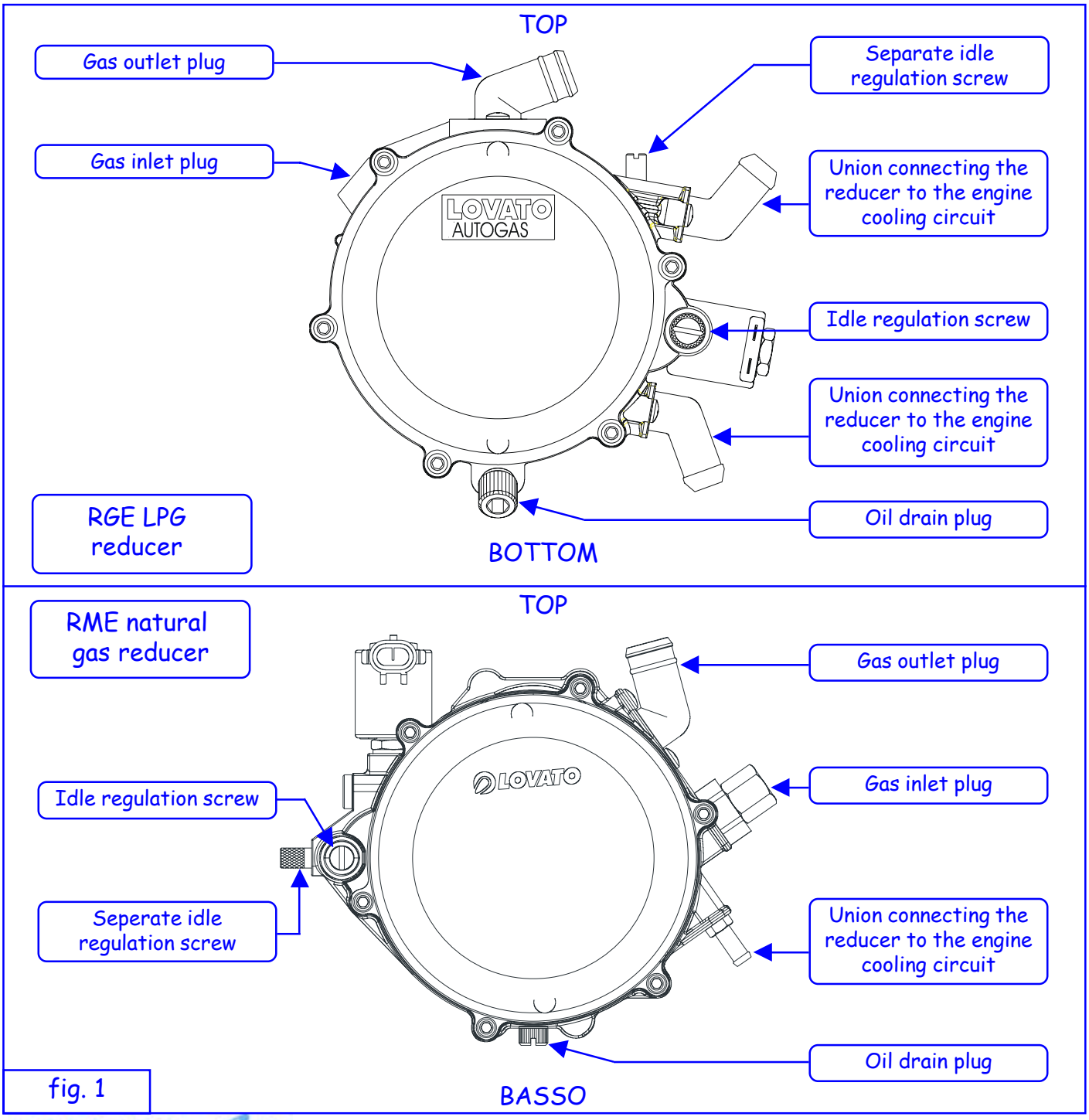
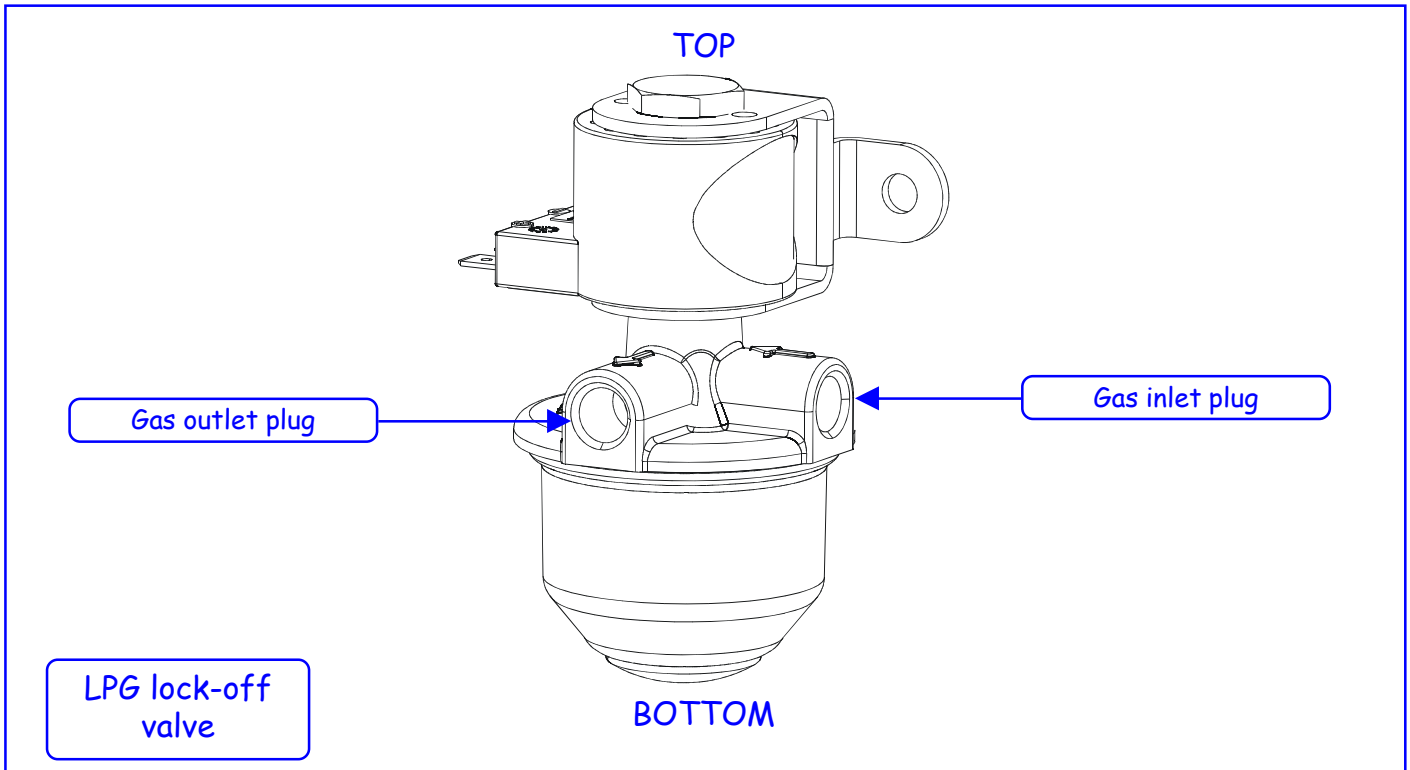


fig. 1

4.2 Locating the installation area for the solenoid valve

After deciding on the assembly area for the reducer, locate the position for mounting the on-off lock-off valve on the high pressure LPG or natural gas line; place the valve as close as possible to the reducer but far away from accident impact zones. Mount the solenoid valve vertically with the coil at the top.



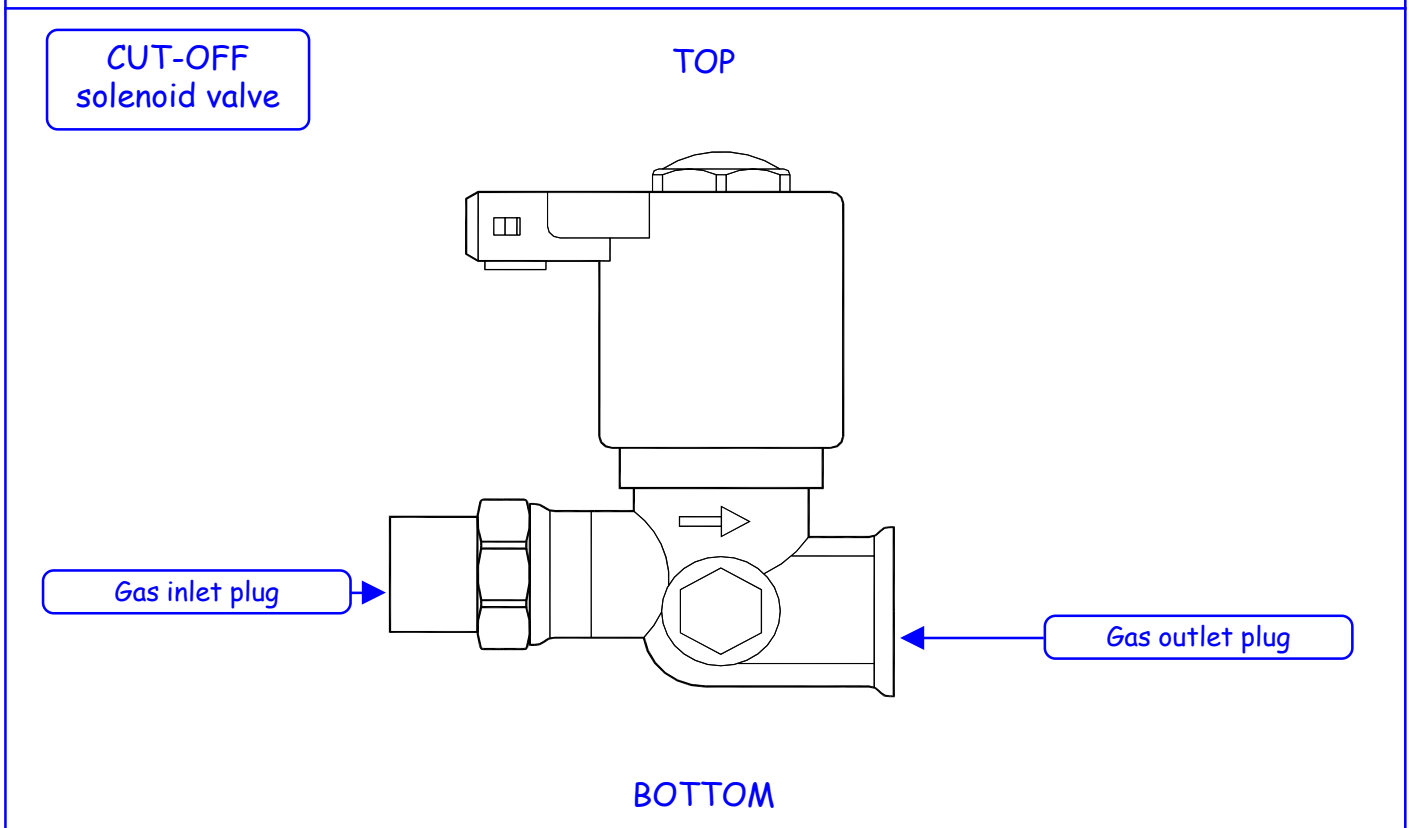


fig. 2

4.3 Installing the solenoid valve

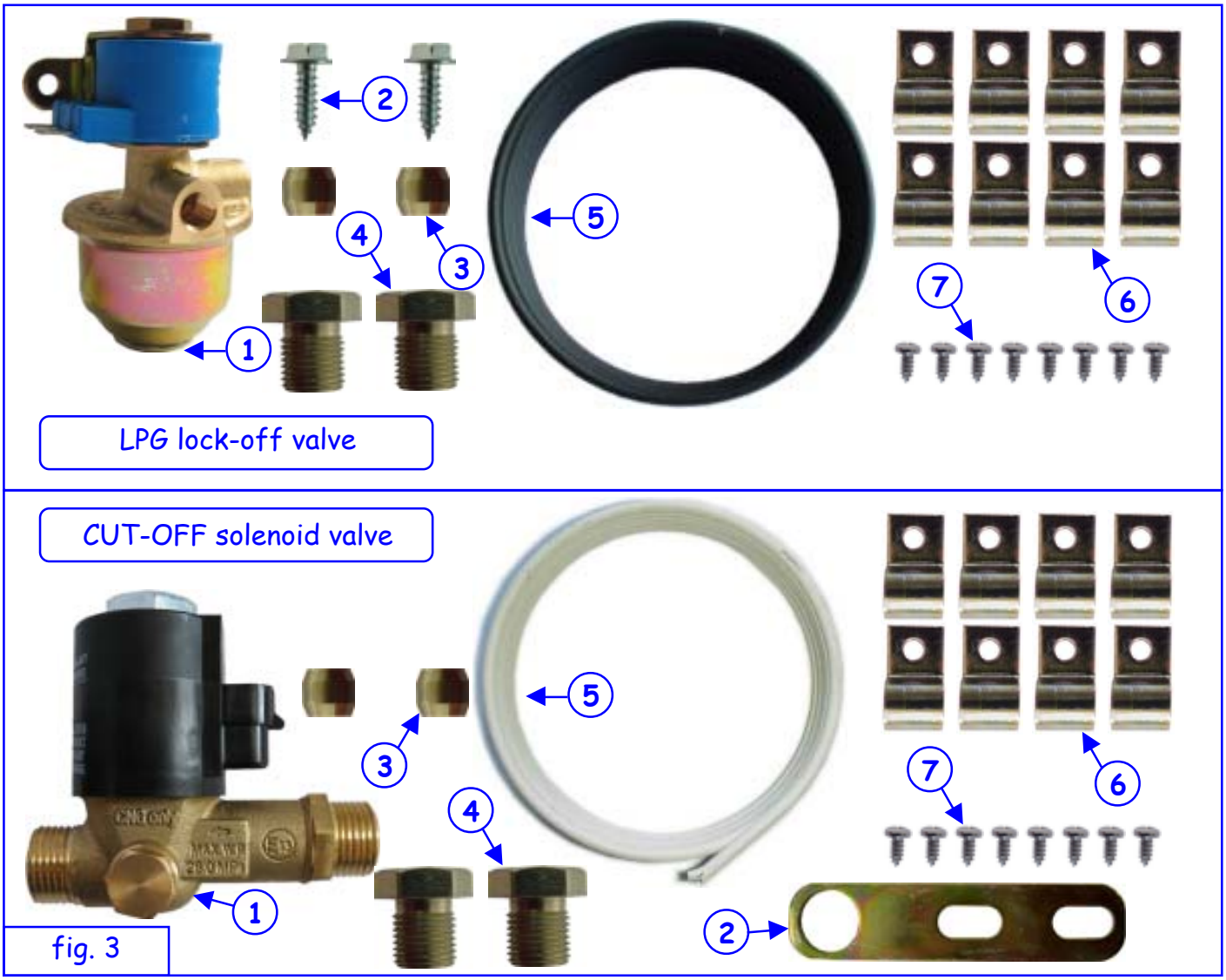


fig. 3

1 LPG lock-off valve (CUT-OFF solenoid valve),
2 4.8x16 self-tapping screws for fixing the LPG lock-off valve to the chassis or bodywork of the car (Bracket for fixing the CUT-OFF solenoid valve to the chassis or bodywork of the car)
3 Ferrule Ø 6 (ferrule Ø 6 in steel),
4 Galvanised connector M10x1 (M10x1 steel connector),
5 Coil of 4x6 copper piping (Coil of 4x6 steel piping)
6 Ø 8 bodywork clamp
7 3.9x9.5 self-tapping screw

Installing the LPG lock-off valve

Fit the LPG lock-off valve before installing the reducer; to do this, use the bracket built into the valve and the two self-tapping screws.
Connect the multivalve mounted on the tank to the LPG lock-off valve with a suitable length of piping. Fix the pipe to the multivalve with the ferrule and the galvanised connector supplied with the multi-valve.
Fix the pipe to the bottom of the car in as protected a position as possible from heat sources and/or accidental impact as this may cause it to deteriorate or break, using the car hose clamp and the self-tapping screws, until it reaches the engine compartment.
Fix the pipe to the gas inlet of the LPG lock-off valve using the double cone and the galvanised connector.
Also prepare a section of copper piping that will connect the solenoid valve to the reducer, fixing it to

the solenoid valve and then to the reducer with the double cone and the relative galvanised connector.

Installing the CUT-OFF solenoid valve

Fit the CUT-OFF solenoid valve before installing the reducer; to do this, use the supplied bracket and bolt.
Connect the filling valve to the CUT-OFF solenoid valve with a suitable length of steel piping.
Fix the pipe to the filling valve using the double cone and the steel connector supplied with the valve.
Fix the pipe to the gas inlet of the CUT-OFF solenoid valve using the double cone and the steel connector.
Also prepare a section of steel piping that will connect the CUT-OFF valve to the pressure reducer, fixing it to the lock-off valve and then to the reducer with the double cone and the relative steel connector.

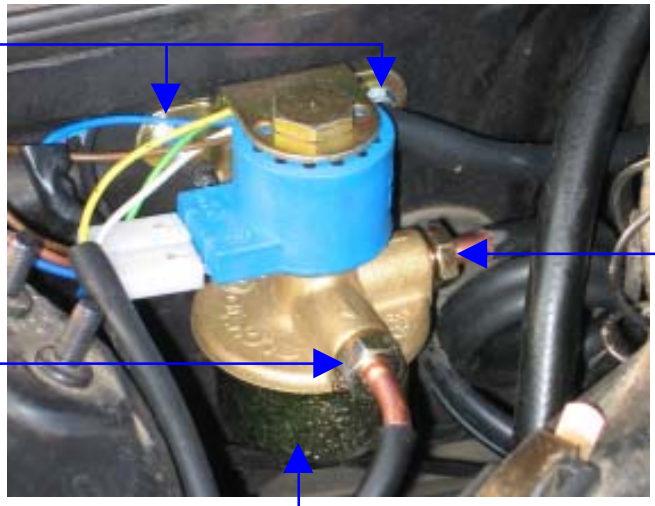

Scew fixing the LPG lock-off valve to the bodywork of the car
LPG inlet
LPG outlet
LPG lock-off valve
CUT-OFF solenoid valve
Bracket and screw fixing the CUT-OFF solenoid valve to the bodywork of the car
Natural gas inlet
Natural gas outlet
Pressure/level sensor

fig. 4

4.4 Mounting the mixer

fig. 5

1 mixer

The mixer must be sized according to the characteristics of the vehicle to convert to LPG (engine capacity – size and physical characteristics of the throttle body - injection type - type of idle management system, etc).
Generally speaking, the mixer is installed on the throttle body, in some cases however it may be necessary to install it inside the air aspiration hose, just outside the air filter box, downline from the airflow measurement device.

Example of installing the mixer inside the aspiration manifold

Example of installing the mixer upline from the airflow measurement device

fig. 6

4.5 Installing the reducer/vaporiser (pressure reducer for natural gas)

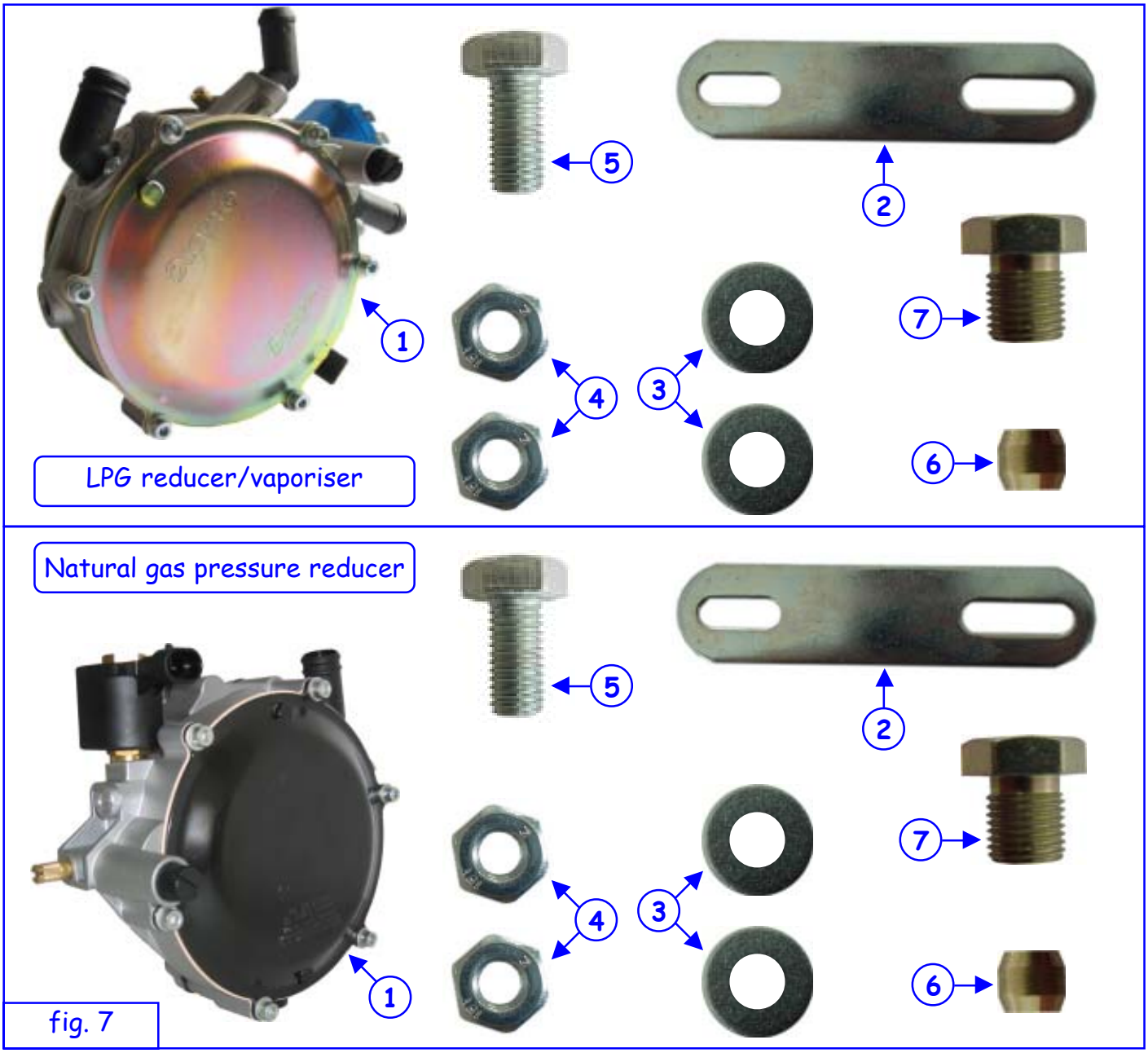


fig. 7

1 Reducer/vaporiser (pressure reducer for natural gas)
2 Reducer fixing bracket
3 Wide M10 washer
4 Hex nut M10
5 Screw M10 x 20
6 Double cone (double cone in steel)
7 Galvanised connector M10x1 (steel connector)

To fix the reducer, proceed as follows.

- If necessary, bend the steel bracket as required .
- Fix the bracket to the reducer using the M10 nut and the washer.

Fit the reducer-bracket assembly to the bodywork of the car in the chosen position using the M10x20 screw and the M10 hex nut (see figure 7).

Mount the reducer vertically with the oil vent screw facing downwards so that the gas outlet pipe faces upwards. The reducer should be positioned parallel to the direction of movement of the vehicle and the water pipes must be roughly directed towards the relative components. Take care to prevent

it from touching moving or hot parts.

LPG reducer/vaporiser installation

Natural gas pressure reducer installation

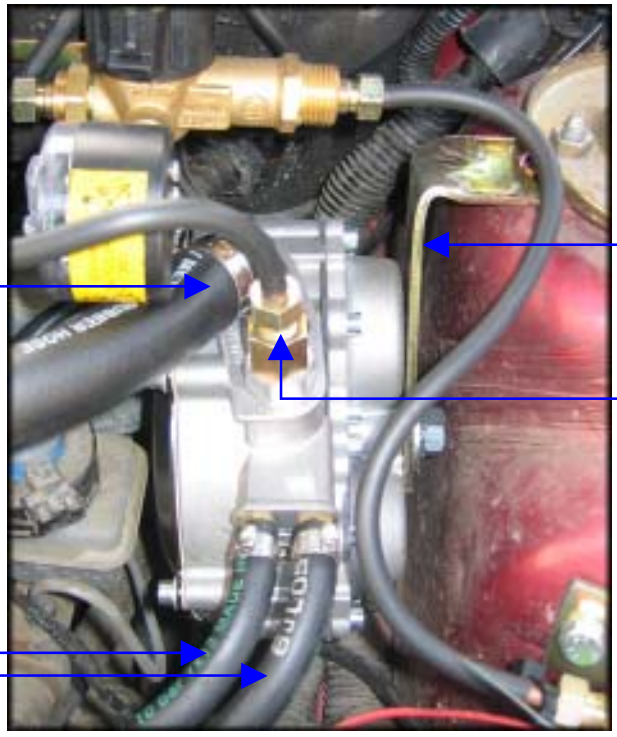


fig. 8

4.5.1 Connecting the reducer to the vehicle cooling circuit

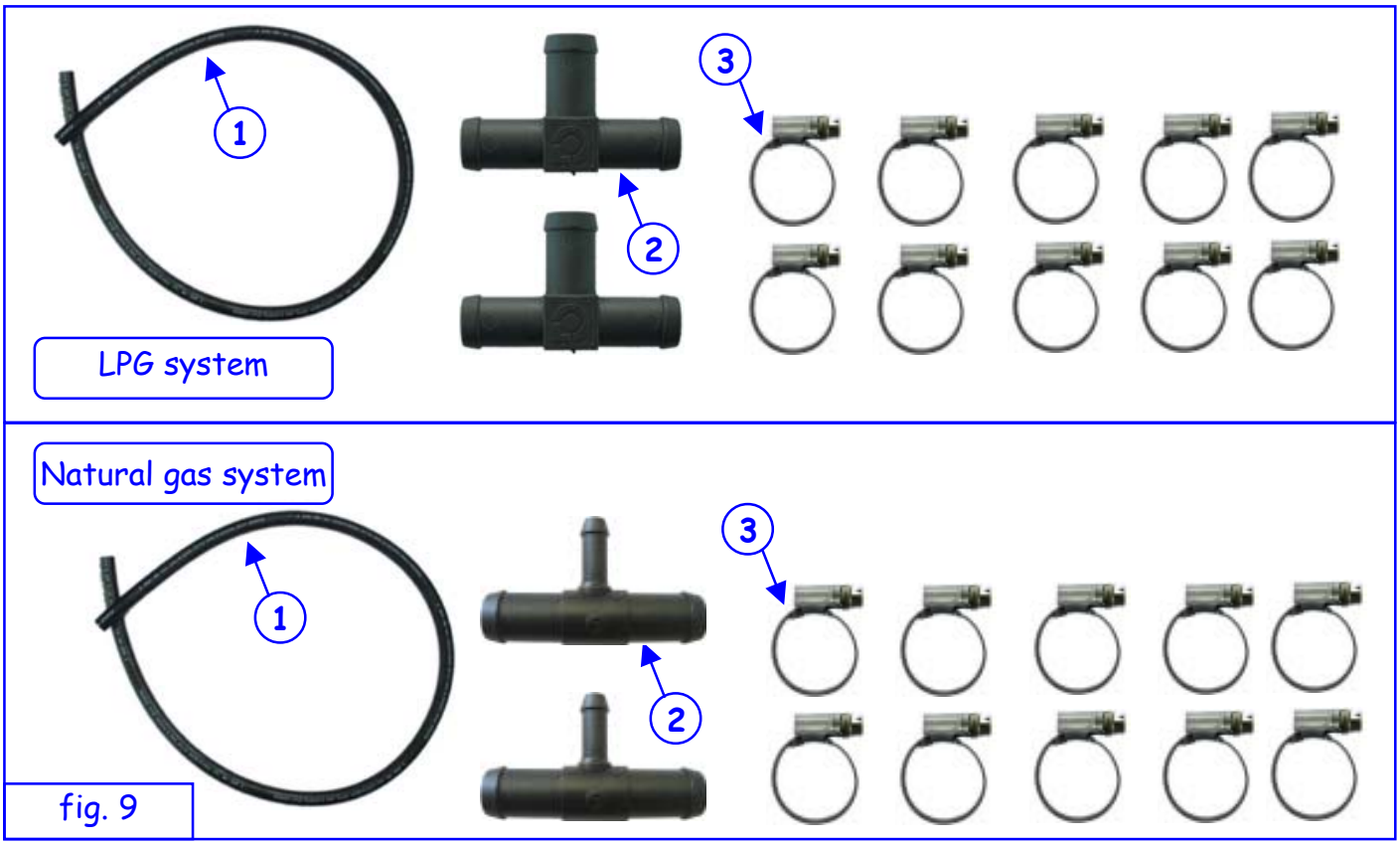
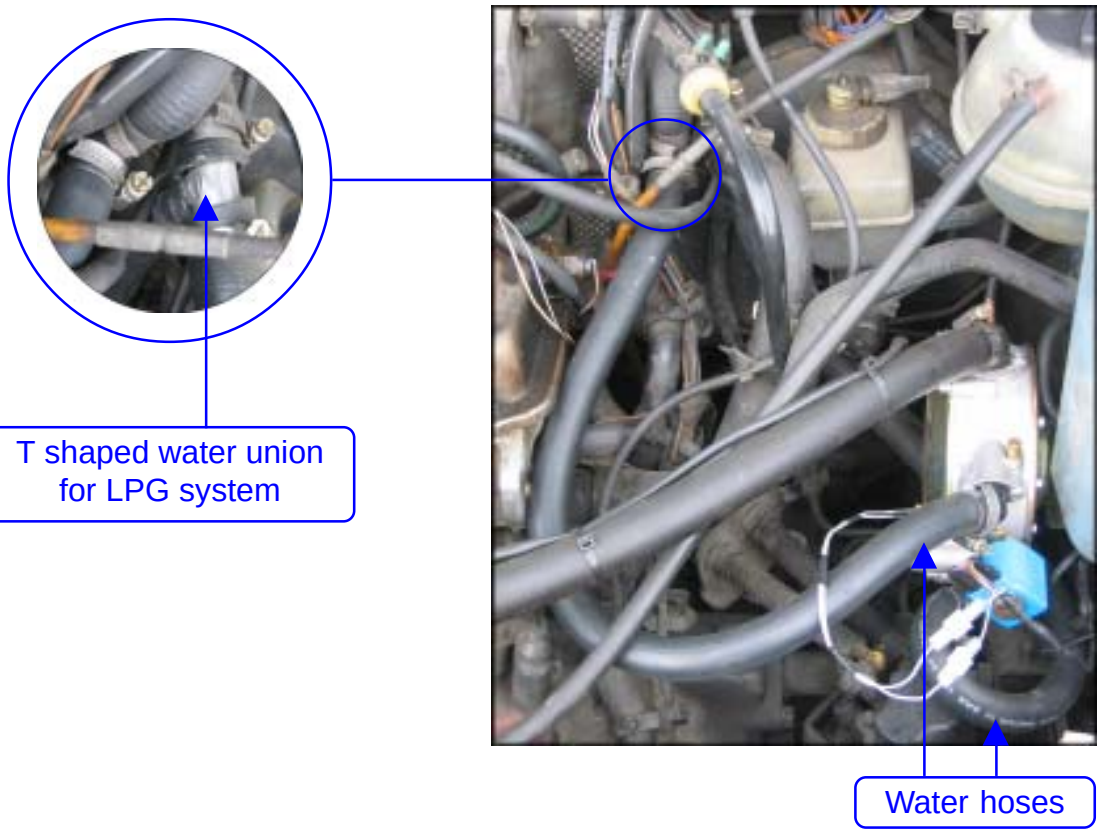


fig. 9

1 Water hose Ø 15x23 (Ø 7x13 hose for natural gas system)
2 T-shaped water union
3 Clamp Ø 16 ÷ 27

Install the reducer heating circuit as shown below, taking care to reduce the loss of liquid coolant to a minimum:

1. cut the two engine coolant hoses at the bulkhead between the engine compartment and the interior, and insert the two T-shaped unions.
2. attach the hoses for heating the reducer to the other ends of the unions.
3. attach the hoses to the relative pipes on the reducer.
4. tighten the entire hydraulic circuit installed with the hose clamps D. 16 - 27.
5. vent the cooling system.


T shaped water union
for LPG system
Water hoses

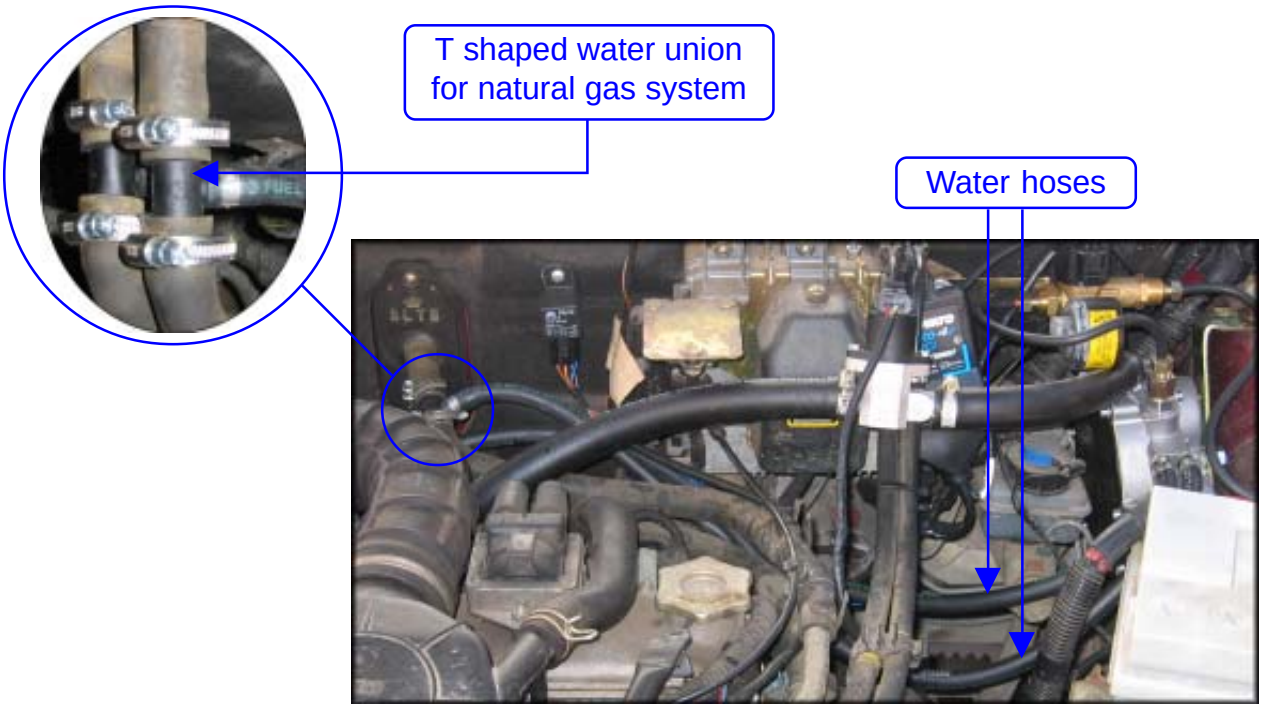

T shaped water union
for natural gas system
Water hoses

fig. 10

4.5.2 Connecting the reducer to the flow actuator and mixer

fig. 11

1 Gas hose E67-R01 Ø 19x27
2 Flow actuator
3 Clamp Ø 19 ÷ 32

Connect the reducer gas outlet with the flow actuator using a length of gas hose Ø 19x27 and fix it with the clamps. Connect the flow actuator to the mixer with another length of hose and fix it with the clamps.

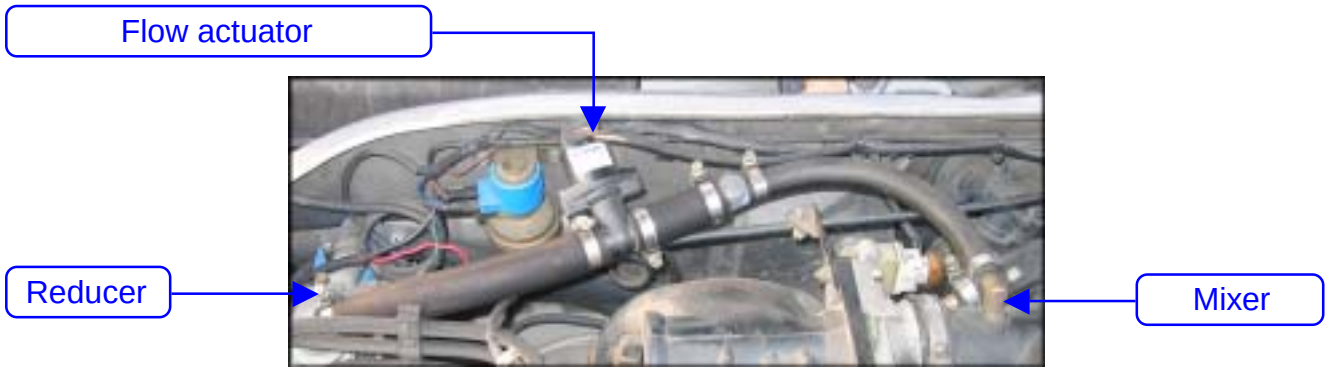


fig. 12

4.6 Installing the Loveco 4EU electronic control unit

fig. 13

1 Electronic control unit
2 4.8x16 self-tapping screw for fixing the control unit to the chassis or bodywork of the car.

Fit the control unit to the bodywork of the car using a self-tapping screw.
The electronic control unit can be positioned either in the engine compartment or in the passenger interior. Make sure to respect the following requirements:

- mount the control unit as far away as possible from the spark plug wires and the high-voltage ignition circuit
- mount the control unit in an area where the temperature is not normally very high; do not position it near the engine exhaust manifold
- do not fix it to the engine assembly
- if it is decided to install the control unit in the engine housing, do not fix it in a position where it can be directly sprayed by water
- generally speaking, it should be positioned near the engine battery.

fig. 14

4.7 Installing the EMULATOR control unit

fig. 15

1 EMULATOR control unit
2 4.8x16 self-tapping screw for fixing the EMU control unit to the chassis or bodywork of the car.

Position the control unit in the chosen point and fix it with the self-tapping screw supplied with the kit.

Position the control unit in the engine compartment taking care to respect the following requirements:

- mount the control unit as far away as possible from the spark plug wires and the high-voltage ignition circuit
- mount the control unit in an area where the temperature is not normally very high; do not position it near the engine exhaust manifold
- do not fix it to the engine assembly
- do not fix it in a position where it can be directly sprayed by water

Generally speaking, it should be positioned near the engine battery.
Connect the control unit to the injectors with the relative cable harness.

fig. 16

5.0 Electrical connections

5.1 RPM signal

The LOVECO 4EU system allows the vehicle to be started in the petrol mode and switched during the release phase. It uses the RPM input to enable switching and to act as the car safety system.
In order to optimise conversion, assess the capture method with care.
The selection criteria is the following:

- Always prefer the RPM signal from the petrol control unit; locate its position on the connector with the wiring diagram of the car or by directly visualising the signals with an oscilloscope
- In some recent models of car, the RPM counter signal is conveyed on the Can Bus and contains no phase information.

In this case, choose the negative signal on the ignition coil.
When capturing this signal, remember that if the grounds of the ignition coil are not in good condition, discharge may be incorrect and generate impulses on the low voltage side that may disturb system operation: in these cases, if it is not possible to eliminate the cause, use a rev amplifier to decouple the circuits.

Make the electrical connection to the rev counter signal or the ignition coil negative signal by stripping the signal wire for a sufficient length to allow the BLACK wire from the LOVECO 4EU control unit to be soft soldered; insulate the connection with insulating tape.
If the LOVECO 4EU control unit does not detect a correct RPM signal, the system will not allow the car to shift from the petrol mode to the LPG mode.

5.2 Lambda probe signal (upline from catalyser)

The Lambda probe signal is used for the NORMALLY ASPIRATED system. Check the Lambda probe works properly in the petrol mode before connecting it to the Loveco 4EU system. To prevent electromagnetic disturbance, do not lay the sheath with the WHITE wire near the ignition coil.
The Lambda probe signal is captured by pinning the WHITE wire of the LOVECO EU4 cable harness to the Lambda probe signal wire (the BLACK wire of the probe is generally the signal wire), or in some types of vehicle the probe signal wire is cut and the probe part connected to the white wire of the Loveco 4EU cable harness and the yellow wire to the original control unit. This makes emulation possible in order to prevent the engine failure indicator LED from lighting up on some cars.

WARNING

THE COLOURS OF THE LAMBDA PROBE WIRES IN THE EXPLANATIONS AND THE ELECTRICAL DIAGRAM REFER TO THE SECTION FROM THE PROBE TO THE CONNECTOR. AS THE SIGNALS ARE ALWAYS CAPTURED AFTER THE PROBE CONNECTOR AND THE COLOURS OF THE WIRES OFTEN CHANGE, MAKE SURE TO REFER TO THE CORRESPONDING WIRE BEFORE THE CONNECTOR.

5.3 Connecting the reducer temperature sensor

The LOVECO 4EU system uses the reducer temperature signal to switch from the petrol to the LPG mode. Switching from petrol to LPG is only allowed with the temperature of the reducer reaches the set switching temperature.
Connect the temperature sensor by attaching the GREY wire of the cable harness to one of the two sensor terminals on the reducer and earthing the other.
If the temperature sensor is not connected, the system will allow you to switch from petrol to LPG at any temperature. In this case, the grey wire should be connected to earth to prevent it from becoming an input for possible disturbance.

5.4 Connecting the level indicator

The LOVECO 4EU system includes a digital fuel level indicator located in the switch. The wiring harness of the Loveco 4EU system is fitted with a level sensor connecting wire. To connect the indicator correctly, consult the wiring diagrams.

5.5 Connecting the multivalve and the LPG solenoid or CUT-OFF valve.

Connect the BLUE wires to the coil power wires.

5.6 Connecting the power lines

Connect the RED / BLACK wire to the positive battery terminal, interposing a 7.5A fuse, and the BROWN wire to the negative battery terminal.
Connect the RED wire to the 12V key (not timed).

WARNING

ALL CONNECTIONS WITHOUT CONNECTORS MUST BE SOFT SOLDERED IN ORDER TO PREVENT RUSTING AND FALSE CONTACTS.

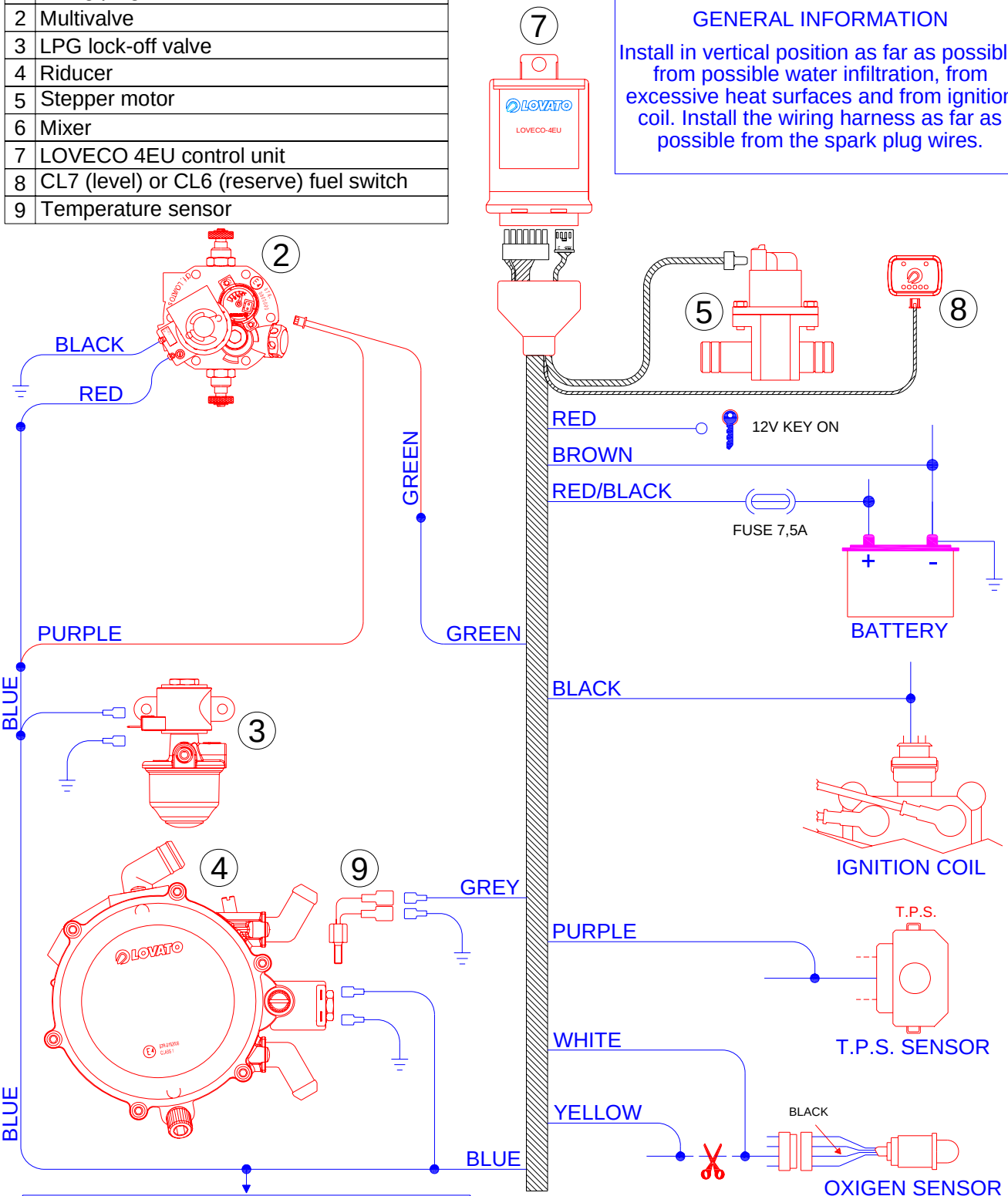
6.0 Wiring diagram

LOVATO	LPG LOVECO-4EU WIRING AND PNEUMATIC DIAGRAMS		revision 000
last revision date: 17-10-06	file name: WD_L4EU_G_0		Pag. 1/1

1	Filling plug
2	Multivalve
3	LPG lock-off valve
4	Riducer
5	Stepper motor
6	Mixer
7	LOVECO 4EU control unit
8	CL7 (level) or CL6 (reserve) fuel switch
9	Temperature sensor

GENERAL INFORMATION

Install in vertical position as far as possible from possible water infiltration, from excessive heat surfaces and from ignition coil. Install the wiring harness as far as possible from the spark plug wires.



INJECTOR INTERRUPTION

Connect to the injector circuit according to the specific LOVATO's wiring diagram.

OXIGEN SENSOR

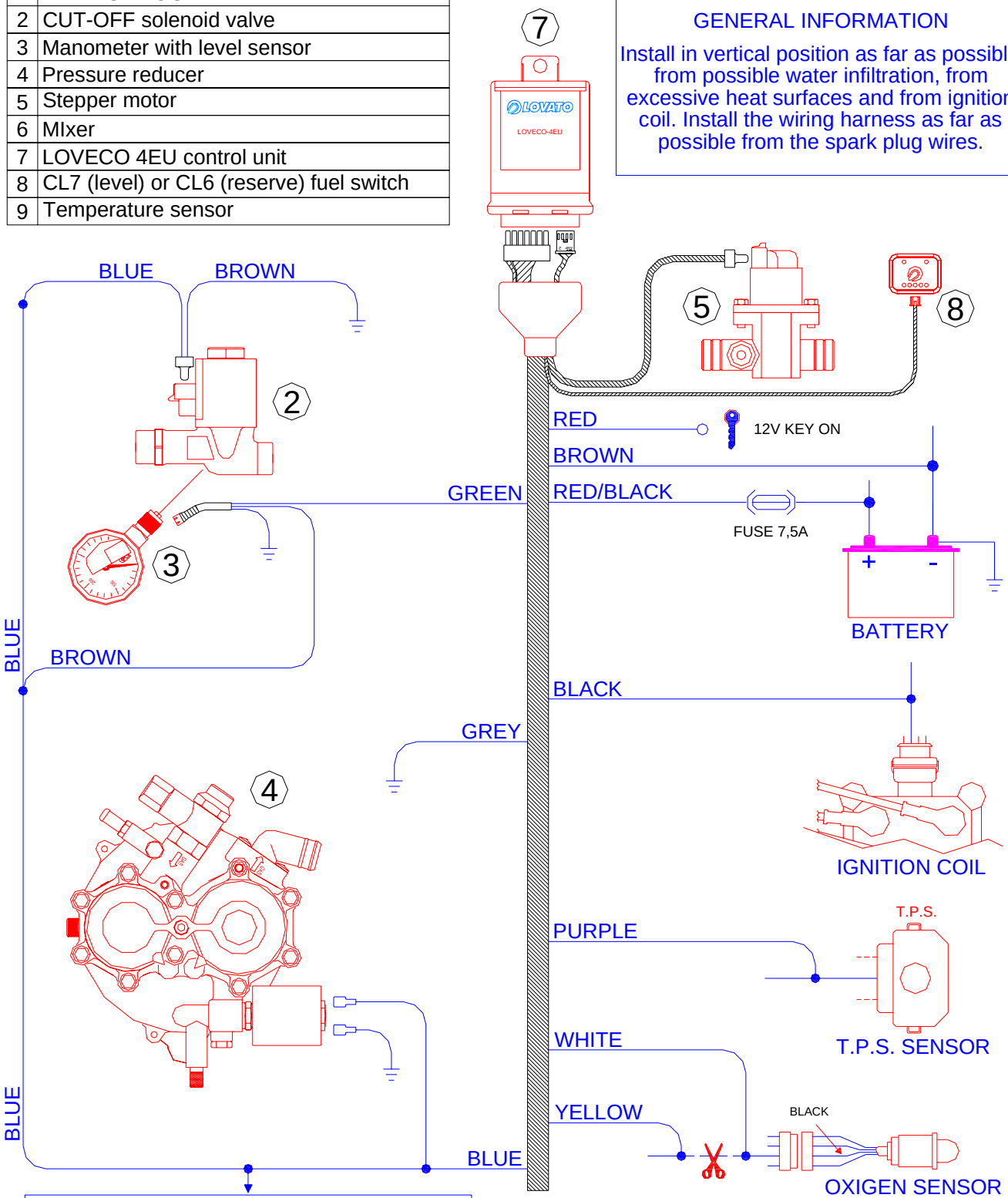
Use the specific LOVATO's wiring diagram

LOVATO	CNG LOVECO-4EU WIRING AND PNEUMATIC DIAGRAMS			
last revision date	file name			revision 000
17-10-06	WD_L4EU_M_0			Pag. 1/1

1	FILLING PLUG
2	CUT-OFF solenoid valve
3	Manometer with level sensor
4	Pressure reducer
5	Stepper motor
6	MIxer
7	LOVECO 4EU control unit
8	CL7 (level) or CL6 (reserve) fuel switch
9	Temperature sensor

GENERAL INFORMATION

Install in vertical position as far as possible from possible water infiltration, from excessive heat surfaces and from ignition coil. Install the wiring harness as far as possible from the spark plug wires.



INJECTOR INTERRUPTION

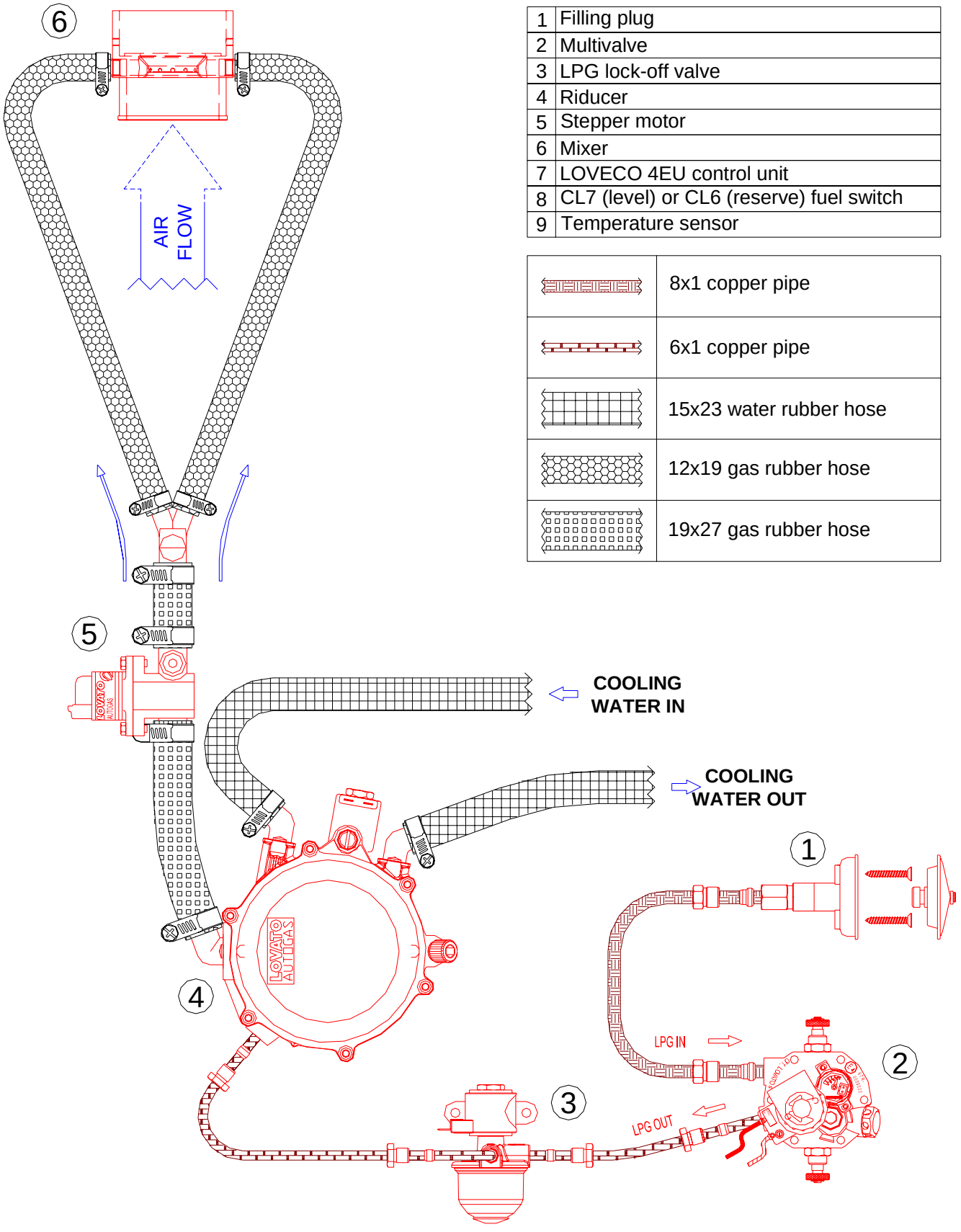
Connect to the injector circuit according to the specific LOVATO's wiring diagram.

OXIGEN SENSOR

Use the specific LOVATO's wiring diagram

7.0 Pneumatic diagram

LOVATO	LPG LOVECO-4EU WIRING AND PNEUMATIC DIAGRAMS		
last revision date: 17-10-06	file name: PD_L4EU_G_0		revision 000
			Pag. 1/1



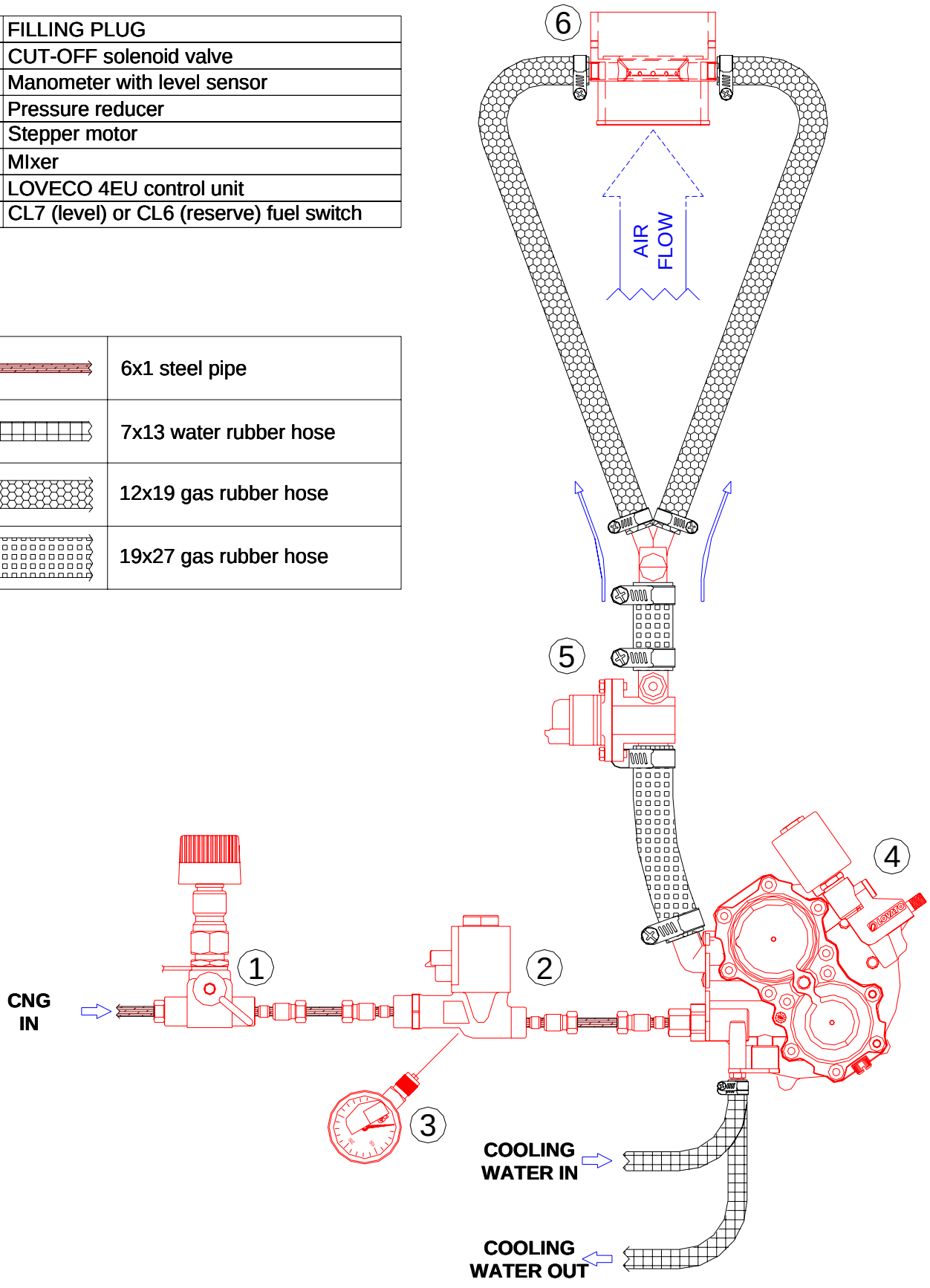
1	Filling plug
2	Multivalve
3	LPG lock-off valve
4	Riducer
5	Stepper motor
6	Mixer
7	LOVECO 4EU control unit
8	CL7 (level) or CL6 (reserve) fuel switch
9	Temperature sensor

	8x1 copper pipe
	6x1 copper pipe
	15x23 water rubber hose
	12x19 gas rubber hose
	19x27 gas rubber hose

last revision date	file name	CNG LOVECO-4EU WIRING AND PNEUMATIC DIAGRAMS		revision 000
17-10-06	PD_L4EU_M_0			Pag. 1/1

1	FILLING PLUG
2	CUT-OFF solenoid valve
3	Manometer with level sensor
4	Pressure reducer
5	Stepper motor
6	MIxer
7	LOVECO 4EU control unit
8	CL7 (level) or CL6 (reserve) fuel switch

	6x1 steel pipe
	7x13 water rubber hose
	12x19 gas rubber hose
	19x27 gas rubber hose



8.0 Calibrating LOVECO-4EU electronic control unit without using a PC.

Initial switch-on

When the fuse is inserted, the control unit signals whether it has been previously configured or not.
- Control unit to be programmed - The 3 leds are on for 30s, then the stepper motor is reset.
- Control unit programmed by PC - The 3 leds blink rapidly for 10s, then the stepper motor is reset.
- Control unit with self-taught data - The 3 leds blink slowly for 10s, then the stepper motor is reset.

Reset procedure

Reset of the control unit with restoration of the default parameters and cancellation of the configuration data can be performed in 2 ways:
- Via the PC by means of appropriate button on the screen
- By manually removing the fuse while the red LED is on (approx. 6 sec.) immediately after powering the control unit and repeating the operation 3 times

Rpm switching threshold modification procedure

Switch the panel on without starting, wait approx. 6 sec. for blinking of the leds on the switch. Switch the panel off and then start, keeping the switch button pressed: a new switching threshold can now be set by reaching the required rpm and pressing the switching button.

Self-calibration procedure

At initial switch-on or after a reset, the control unit goes to self-teach mode. Wait for reset of the stepper motor (the 3 leds of the control unit are on for 30 sec) and turn the key to start the procedure. The steps to be followed are schematised in the following table.

WARNING

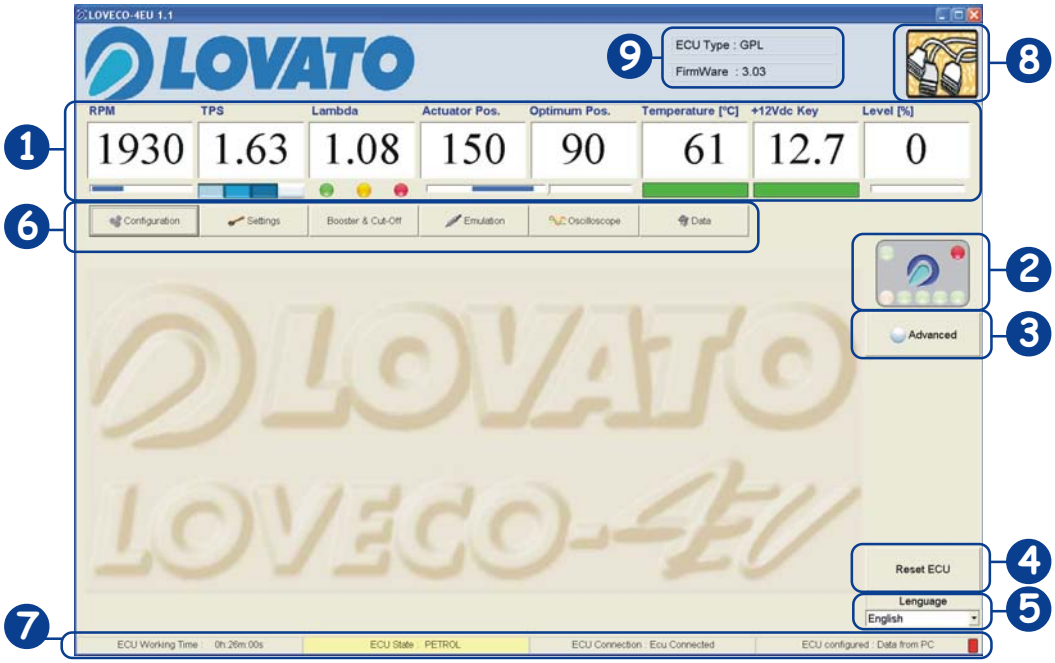
THE LAMBDA PROBE MUST BE WARM AND OPERATING CORRECTLY.

KEY	LEDS ON	BLINKING LEDS	LED IN SEQUENCE	NORMAL OPERATION	LEDS OFF

SEQUENCE				ACTION	FUNCTION
	LEVEL	ECU	RESERVE		
TPS				SWITCH ON PANEL WITHOUT STARTING.	SELF-CALIBRATION START.
				WAIT FOR NEXT STEP.	TPS ACQUISITION WITHOUT ACCELERATION.
				KEEP THE PEDAL PRESSED RIGHT DOWN.	TPS ACQUISITION WITH ACCELERATOR FULLY PRESSED.
				WAIT FOR NEXT STEP.	END OF TPS ACQUISITION.
LAMBDA				METTERE IN MOTO E PORTARSI A 2000÷2500 G/M.	PALLEGGIO LAMBDA.
				KEEP THE ENGINE AT 2000/2500 RPM.	LAMBDA ACQUISITION.
				RETURN TO MINIMUM BY RELEASING THE PEDAL.	END OF LAMBDA ACQUISITION.
RPM THRESHOLD				REACH THE SWITCHING THRESHOLD AND PRESS THE BUTTON.	ACQUISITION OF RPM SWITCHING THRESHOLD.
				GO TO NEXT STEP.	END OF RPM THRESHOLD ACQUISITION. THE CAR IS SET TO RUN ON PETROL.
OPTIMAL POSITION CALCULATION				PRESS BUTTON TO ENABLE SWITCHOVER TO GAS.	THE CAR IS READY TO SWITCH.
				EXCEED THE SWITCHING THRESHOLD AND DECELERATE TO SWITCH TO GAS.	THE CAR IS RUNNING ON GAS.
				GET UP TO 2000/2500 RPM AND MAINTAIN FOR APPROX. ONE MINUTE	OPTIMAL POSITION CALCULATION.
				CHECK FOR ANY OPTIMAL POSITIONS THAT ARE TOO HIGH OR TOO LOW BY MONITORING THE SIGNALS ON THE SWITCH (ON THE CONTROLL UNIT TOO).	BLINKING GREEN LIGH - optimal position too high, - exhaust mixture threfore contains too much air.
					BLINKING GREEN LIGHT - optimal position too low, - exhaust mixture threfore contains too much fuel.
END				END OF PROCEDURE.	THE CAR IS SET TO GAS READY FOR USE.

9.0 Loveco 4EU interface software.

The Loveco 4EU software comprises a graphic interface that can be used to modify all the parameters and settings of the Loveco 4EU control units. This software only works correctly when the computer is connected to a powered and operating control unit. Connect the control unit to the PC with the serial cable supplied to fitters, together with the USB/Serial adapter, if necessary. When the programme starts, the following screen appears.



In this initial page, some fundamental points can be observed:

1. It displays all the information concerning the operating parameters of the control unit, such as:
   - **RPM**. Indicates the revolution of the engine.
   - **TPS**. The 4 square boxes under the value of TPS in volts represent the operating conditions. The first from the left lights up when the engine is idling. The second lights up when the TPS is just above idle. The third lights up when the engine is out of idle. The last lights up when the accelerator pedal is pressed down to the floor and the engine is running at full throttle.
   - **Lambda**. The three indicators under the signal in Volts indicate whether the probe is rich or lean. When the green LED lights up, the lambda probe signals that the mixture is lean while when the red LED lights up the mixture is rich. If just the yellow indicator lights, up the air-gas mixture is optimal.
   - **Instantaneous position of actuator**. Indicates the instantaneous position of the flow actuator.
   - **Optimal position of actuator**. A small bar with a grey indicator and a blue strip is located under the instantaneous position and optimal position indicators. The grey indicator marks the actual position of the stepper motor while the blue strip indicates the range of the stepper motor.
   - **Reducer Temperature**. The indicator under the reducer temperature box shines red if the reducer is not at the right temperature and green when the reducer is warm enough to allow switching to gas.
   - **Voltage +12V Key**. The indicator under this box shines green when the key is on.
   - **Fuel level**. This box turns red when the gas is about to run out (the level is lower than 10% of the capacity of the tank)
2. It is a button, reproducing the real switch, that switches from petrol to gas and gas to petrol. This switch is either a level or a reserve switch depending on the type of control unit it is connected to. The reserve switch only has one LED which shines red when the car is running on petrol and

green when it is running on gas. When the car is ready to switch to gas, the LED shines yellow. The level switch (as shown in figure 1) has 2 status LED's and 5 level LED's. The status LED to the right shines red when the car is running on petrol and turns off when the car is running on gas. Vice-versa, the LED to the left shines green when the car is running on gas and turns off when the car is running on petrol. When the car is ready to switch to gas, the two LED's flash together. The level LED's comprise 1 red LED (on the far left), indicating reserve, and four green LED's indicating 1/4, 2/4, 3/4, 4/4 of the tank respectively.

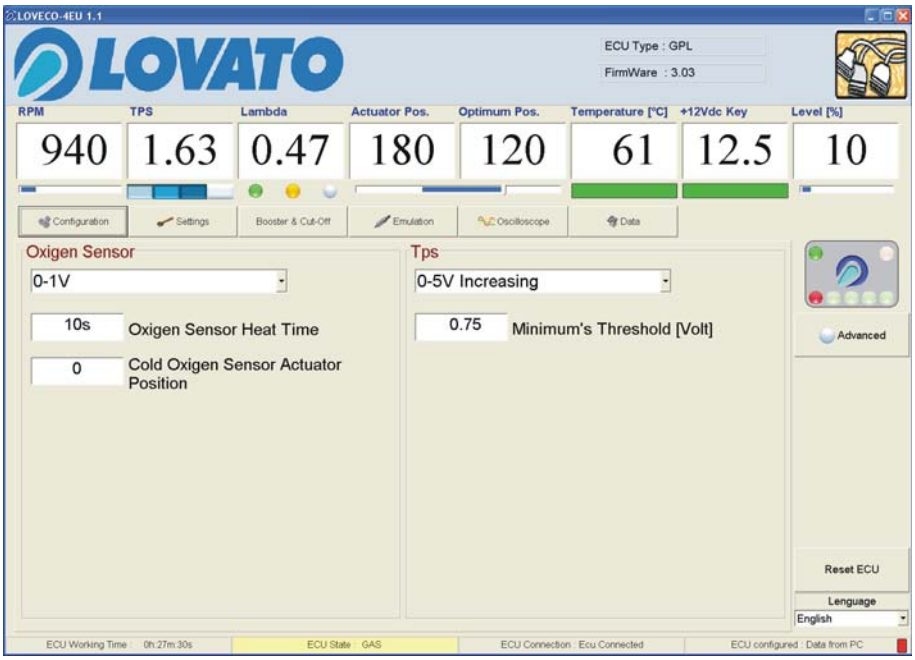
3. There is a button for selecting the Basic/Advanced user mode. The basic mode incorporates the most commonly used parameters and functions. The basic user mode is more than sufficient for all types of installation. The advanced user mode allows access to some parameters that refine the calibration of the control unit and improve its functionality.
4. There is a button for resetting the control unit
5. The language in which all the video messages are displayed can be selected.
6. Using 6 different windows (with relative icons) all the control unit options one can be configured and all the information about the car on which the control unit is installed can be entered.
7. The status bar at the bottom displays the following information:
   - Control unit and computer communication status.
   - Overall gas operating time. This time is updated every 15 seconds.
   - Type of programming performed on the control unit. If the control unit is blank, the message "Blank" appears on the bar together with a white LED. If the control unit has been calibrated from the computer, a red LED appears, and if the control unit has been automatically calibrated, the LED turns green.
8. If the image shows a red cross, the computer is unable to establish communication with the control unit. In this case, the control unit unconnected status is shown in red on the status bar.
9. Here is showed the control unit type (LPG or CNG) and the firmware version.

When it is connected, the computer takes a few seconds to establish a connection.
The 6 buttons on the screen performed the following operations:

- Press the "**Configuration**" button to enter information about the characteristics of the car, such as the TPS and the Lambda probe.
- Press the "**Settings**" button to enter the settings concerning the RPM switching threshold, opening and closing the actuator, optimal position, and switching temperature threshold
- The "**Booster & CUT OFF** " button enables the idle/out-of-idle booster settings and cut-off.
- The "Emulation" button is used to set all the information concerning the emulation of the lambda probe.
- The "**Oscilloscope**" button displays a graph showing the 4 main operating parameters.
- The "**Data**" button is used to save and load control unit data.

9.1 Example of Calibration as a basic user and complete description of parameters.

It is fairly simple to calibrate a Loveco 4EU control unit as just a few fundamental parameters must be entered. Each control unit, in fact, possesses a set of basic parameters which are already calibrated to operate with almost every car on the road.
To simplify calibration, all the missing parameters required are shown in grey.
To calibrate a Loveco 4EU control unit, press the relative button to open the engine "Configuration" window . The following screen appears:



The two Lambda Probe and TPS boxes are displayed. Each of the two boxes contains a drop-down menu in grey indicating that the two pieces of information about the type of lambda probe and the type of TPS mounted on the car must be selected.
by the "**Oxigen sensor**" box the correct type of probe can be selected. You can choose from 5 types:

1. 0-1V
2. 0-5V straight
3. 0-5V inverted
4. 0.8-1.6V
5. 0-1V resistive

When the required lambda probe is selected, the drop-down menu changes colour from grey to white indicating that the control unit has received the setting.
The parameters in this box are described below.

- **Heating time**. Indicates the heating time for the Lambda probe. When the car switches to gas, the lambda probe signal is ignored for the time indicated in this parameter. During this period of time, the actuator remains in the position indicated in the subsequent parameter, Position with lambda cold. During this time, the car totally ignores the information read by the lambda probe. When the lambda probe is cold, the signal it produces cannot be used and may cause the gas system to work incorrectly. The default value for this parameter is 10s. It is not normally necessary to modify this parameter as the car first runs on petrol and the lambda probe has all the time it needs to warm up before it switches to gas.
- **Position with lambda cold**. This parameter specifies an offset, with respect to the optimal position, to which the stepper motor moves when switching to gas. If, for example, the optimal position is 87 and this parameter is set to -10, when the car switches to gas, the stepper motor moves to 77 and remains there for the time specified in the probe heating time parameter. It is not normally necessary to modify this parameter as the instantaneous position of the actuator is very close to the optimal position when the car is running on gas. Values between -15 and + 15 should always be used.

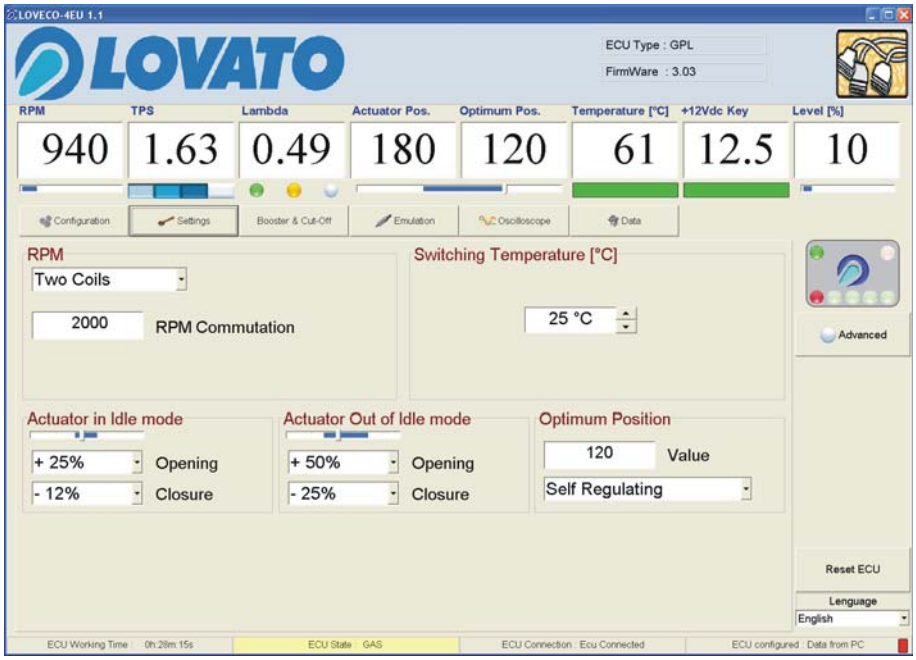
In the "**TPS**" box on the left. 1 of 5 different items can be selected from the drop-down menu, depending on the type of sensor mounted on the car. The types combinations are available:

1. 0-5V Rising.
2. 0-5V Falling.
3. Switch Rising.
4. Switch Falling.
5. TPS not Connected.

Also in this case, when an item is selected, the drop-down menu changes colour from grey to white indicating that the control unit has received the setting.
The parameter in the TPS box is described below.

- **Minimum threshold**. This parameter indicates a threshold voltage. The default value changes depending on the type of sensor selected in the drop-down menu. It is not generally necessary to change this parameter as the default value adapts very well to almost all the cars on the road. When the sensor type is “0-5V Rising” or “Switch Rising”, the value of this parameter indicates a voltage threshold above which the Loveco 4EU control unit recognises the change from idle to out-of-idle. If “0-5V Falling” or “Switch Falling” has been selected from the drop-down menu, this threshold indicates the voltage value below which the Loveco 4EU control unit recognises the change from idle to out-of-idle. If, instead, the TPS sensor is not connected, this parameter has no meaning and is not used.

When both the TPS and the Lambda Probe have been selected, press the “Settings” button to move on to the following step. The following window opens:



There are several boxes in this window: **RPM**, **Switching Temperature**, Opening and Closing the actuator in the various operating conditions of the car and, lastly, the optimal position of the actuator.

The **RPM** box contains the following parameters:

- The “**RPM Switching**” box in grey. This is the last parameter required to programme the Loveco 4EU control unit. Recommended values range from 2000 to 2500 rpm.
- A drop-down menu for selecting the number of coils mounted on the car. The number of RPM displayed varies depending on the number of coils mounted.

The temperature the reducer must reach to enable gas switching can be set in the “**Switching Temperature**” box. The default value is 25°C, but this can be changed from 5°C to + 70 °C in steps of 5. This information is only used to enable switching to gas and it is generally not necessary to change it. When the car is already working on gas, this information is ignored. The temperature of the reducer, however, is displayed on the PC graphic interface as it can simplify the work of the fitter and is useful when troubleshooting the system in general. If the reducer temperature signal is not connected or connected to earth, the Loveco 4EU control unit ignores the control of reducer temperature.

In the two “**Actuator at Idle**” and “**Actuator out-of-Idle**” boxes, the operating ranges of the stepper motor can be set to the same operating conditions as those of the car. Each box contains a bar with an indicator marking the optimal operating position of the stepper motor (if the control unit is blank,

the optimal position is set to 90 steps). The blue strips on each of the bars indicate the quality of the operating ranges of the stepper motor in the various operating conditions of the car. The drop-down menu can be used to modify the upper and lower limits of the operating range. Opening values can be:

- Disabled
- +50%
- +25%
- +12%
- +6%

while closings values can be:

- Disabled
- -50%
- -25%
- -12%
- -6%

When “Disabled” is selected, the operating limit of the stepper motor is 20 steps for closing or 240 steps for opening. The items expressed in percentages refer to the optimal position. For example, if the optimal position is 80 steps with closing at -25% and opening at + 50%, the stepper motor will operate between 60 (80 – 20) and 120 (80 + 40) steps. If the optimal position changes, the stepper motor operating limits also change.

In the “**Optimal Position**” box, the optimal operating position of the stepper motor can be entered while the method for updating this value can be selected from the drop-down menu.
The drop-down menu offers 3 different options:

- **Fixed optimal position**. This sets a fixed optimal position with the operating range featuring the opening and closing values described above. As the optimal position is fixed, the operating range of the stepper motor is constant.
- **Self-Adjusting optimal position**. In this case, the optimal position changes over time according to changes in the operating conditions (ageing, mechanical wear, dirty gas filters, etc.) and the load of the car. When the optimal position varies, the operating range of the stepper motor changes too.
- **Fixed Register**. This is an emergency operating mode. The stepper motor is forced to maintain the set optimal position. In these conditions, the stepper motor acts as a fixed register to all effects and purposes. This operating method is used in the event of a mechanical or pneumatic problem (e.g.: the lambda probe is faulty and there is therefore no feedback). The car manages to run on gas while waiting to solve the problem.

The default condition on LPG is “Self-Adjustment Optimal Position” with an optimal position of 90 steps.
When the system has been correctly installed, the optimal operating position normally ranges between 60 and 120 steps. Of course, the value depends on the reducer, the mixer, the characteristics of the car, etc.. When the optimal position values are less than 60 or greater than 120 themixer is not suitable for the car.
The default condition on CNG is “Fixed Optimal Position” with an optimal position of 90 steps.

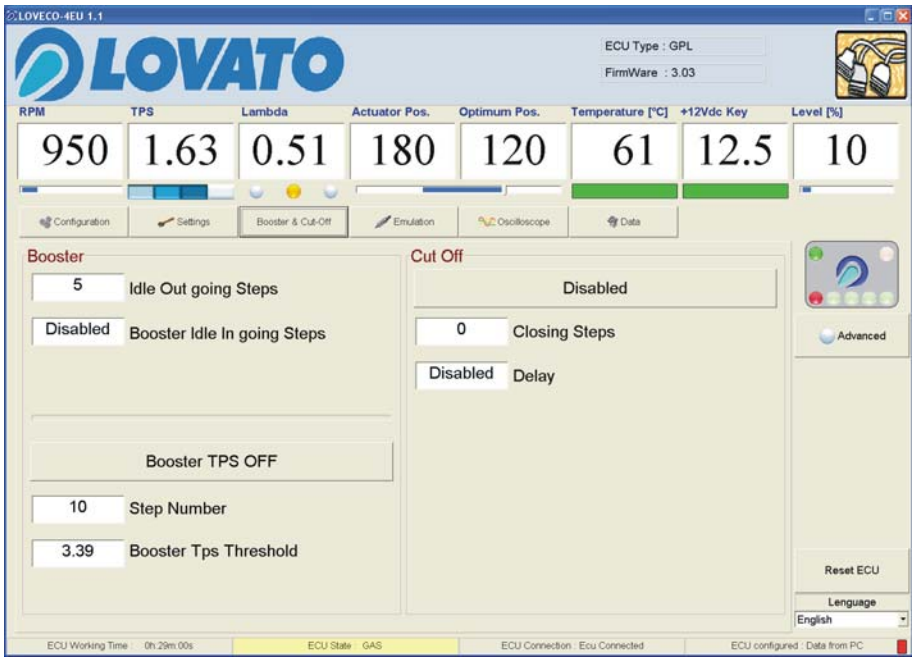
At this point, the control unit calibration procedure has terminated.

To sum up, at least the following three parameters are required to calibrate the control unit:

1. The type of lambda probe mounted on the car.
2. The type of TPS sensor.
3. The Revs Threshold for switching to gas.

As a further parameter, the optimal position can be entered even though, with the default settings, this is automatically read by the control unit the first time the car switches to gas.

Press the “**Booster & CUT-OFF**” button to display the following screen.



There are two boxes in this window: “**Booster”** and **“CUT-OFF**”. The two buttons in each box are used to enable/disable the respective functions.

The following parameters are available in the Booster box:

- **Idle to out-of-idle steps**. This field is used to enter the number of offset steps, with respect to the ACTUAL position, the stepper motor must take when the accelerator pedal is pressed to move from idle to out-of-idle. Both positive and negative values can be entered in this field. In any case, the position of the actuator cannot leave the ranges bound by the maximum closing and the maximum opening values of the actuator. This parameter is usually set to fairly low **positive values**, from +5 to +15 steps. After a brief pause, the stepper motor starts working again, following the feedback from the lambda probe.
- **Out-of-idle to Idle steps**. This field is used to enter the number of offset steps, with respect to the ACTUAL position, the stepper motor must take when the accelerator pedal is released to return to idle. Both positive and negative values can be entered in this field, too. This field is disabled by default. **Negative values** from -5 to -15 steps are normally entered. After a brief pause, the stepper motor starts working again, following the feedback from the lambda probe.

Press the “Booster TPS” button to display a further two data fields and enable the booster on the voltage signal read by the accelerator. The Booster on the TPS is normally disabled and may only be enabled using the PC software.

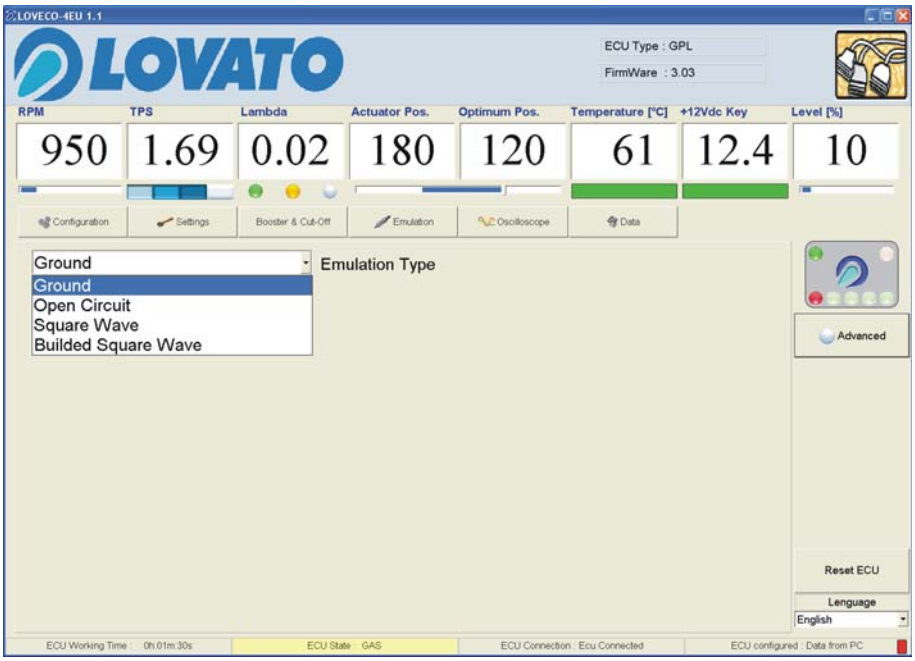
- **Steps**. This field indicates the number of steps added to the actual position when the accelerator pedal is pressed to increase power (e.g.: when overtaking). After a few moments, the stepper motor resumes following the feedback from the lambda probe and the effect of the booster wears off. **Positive values** (the stepper motor opens) of not more than 20 steps are generally used. The operating position of the stepper motor may never exceed the opening and closing limits described in the actuator settings section.
- **TPS threshold for Booster**. This parameter is used to select the voltage provided by the TPS at which the previous parameter cuts in. In the example in the figure, the actual position of the stepper motor is incremented by 10 steps only after the accelerator pedal has been pressed and the TPS signal has exceeded 3.39V. These are the default values. Too high a value makes the Booster cut in only when the pedal is pressed fully down while too low a value causes the Booster to cut in continuously as soon as the idle status is left and may consequently cause the optimal operating position to drift (only with the self-adjustment optimal position).

The CUT-OFF box contains the Enable/Disable button. The CUT-OFF is normally disabled and can only be enabled from the PC software. The Cut Off has been designed to trigger when the accelerator pedal is released. Cut-off status is recognised when the accelerator pedal remains in the idle position for a sufficiently long time. Cut-off status can either be interrupted through TPS pressure or when the number of RPM falls and the engine runs near the idle position. The following parameters can be used to adjust cut-off operation.

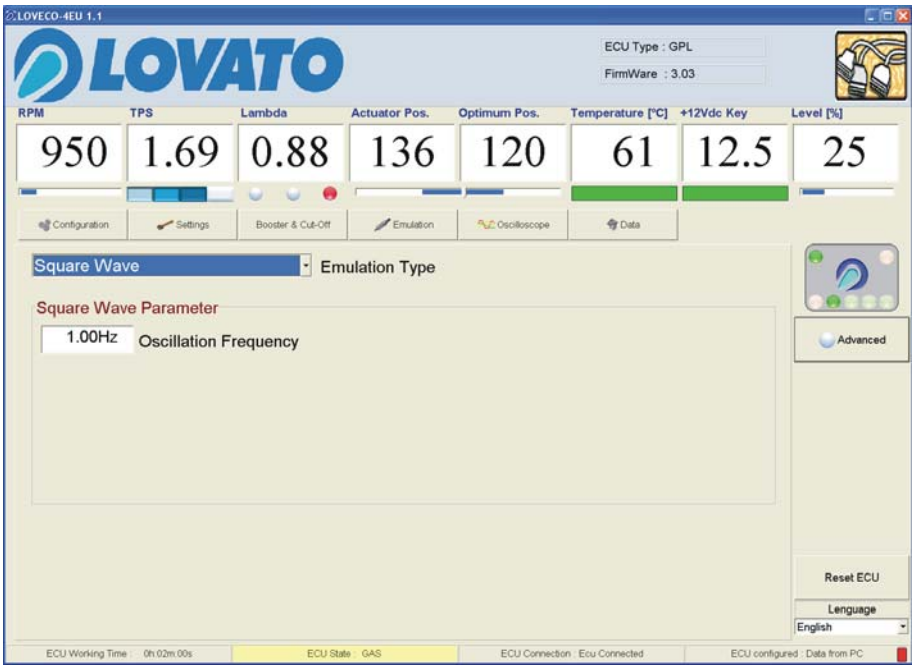
- **Closing steps**. During the Cut-Off phase, the position of the stepper motor decreases with respect to the optimal position in order to reduce the flow of gas to the engine. This parameter, therefore, indicates the number of steps deducted with respect to the optimal position. In this particular case, the instantaneous position may exceed the limits set by the stepper motor operating range. This means that if, for example, the optimal position is 80, the stepper motor is operating between 60 and 120 steps and 30 closing steps are set for the cut-off mode, the stepper motor moves to 50 steps, thus leaving the normal operating range.
- **Delay**. This field indicates the time that the Loveco 4EU control unit waits before recognising the Cut-Off, starting from when the accelerator pedal is released. Values greater than 2 - 3 seconds should be used as otherwise, every time the accelerator pedal is released, it is considered as a cut-off (e.g.: when changing gear).

Press the "**Emulation**" button to select the lambda probe emulation type.

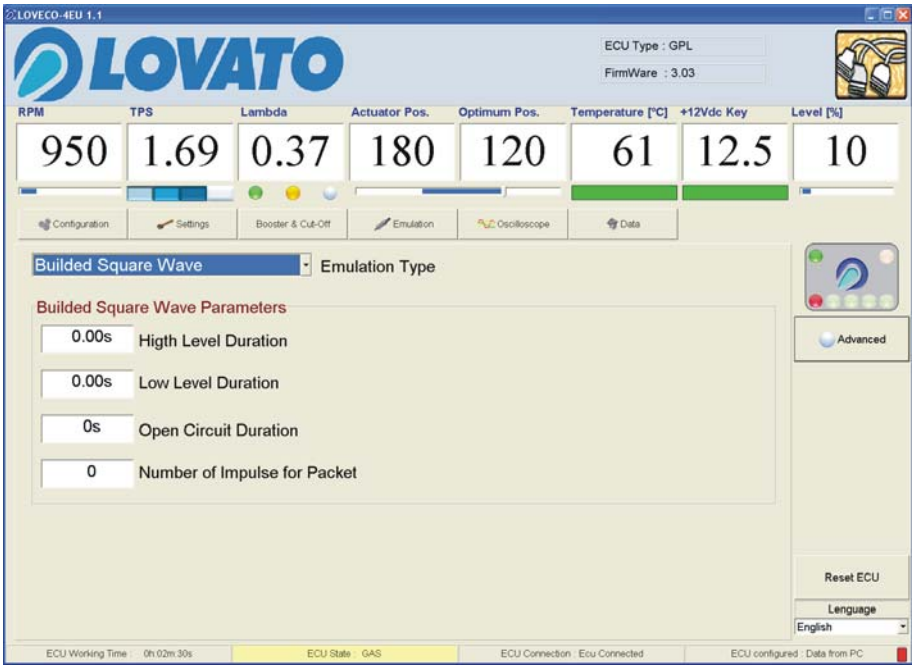
The drop-down menu in the new window offers a choice of 5 different emulations.
The first two lambda probe emulation types are very simple and do not require parameters while the other three require a certain amount of data in order to operate correctly. The various emulation types are described below.



- **To Earth**. The direct wire to the petrol control unit is connected to earth.
- **Open circuit**. The direct wire to the petrol control unit is physically disconnected.

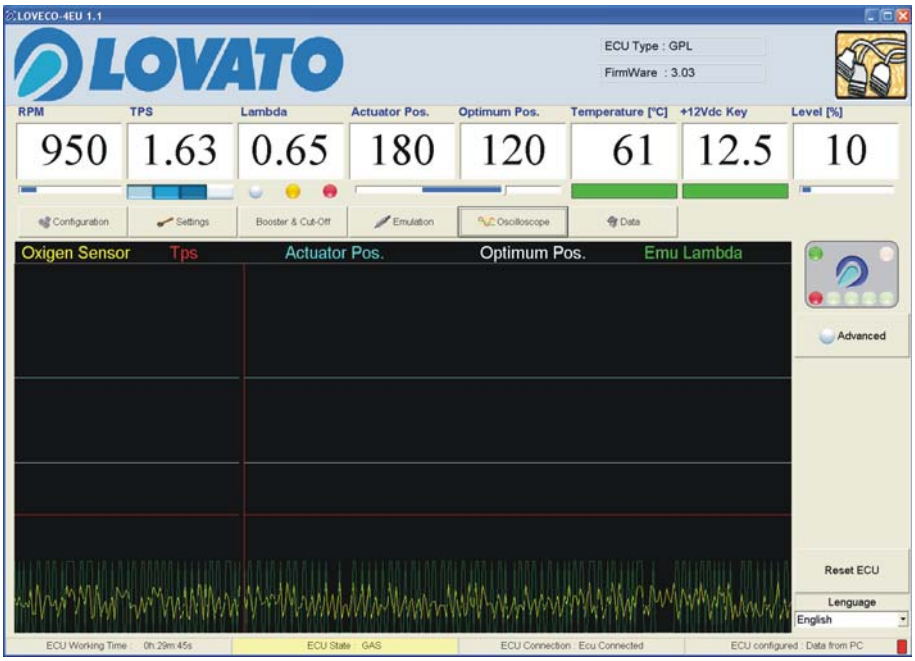


- **Square Wave**. The direct signal to the petrol control unit is generated with a square wave (50% high 50% low), entering alternation frequency.



- **Created square wave**. The direct signal to the petrol control unit is produced with a square wave defining high-level and low level duration, the number of times the two levels must be repeated before interrupting the signal (if necessary) and the duration of signal interruption (if necessary).

Press the “**Oscilloscope**” button to open the following window:

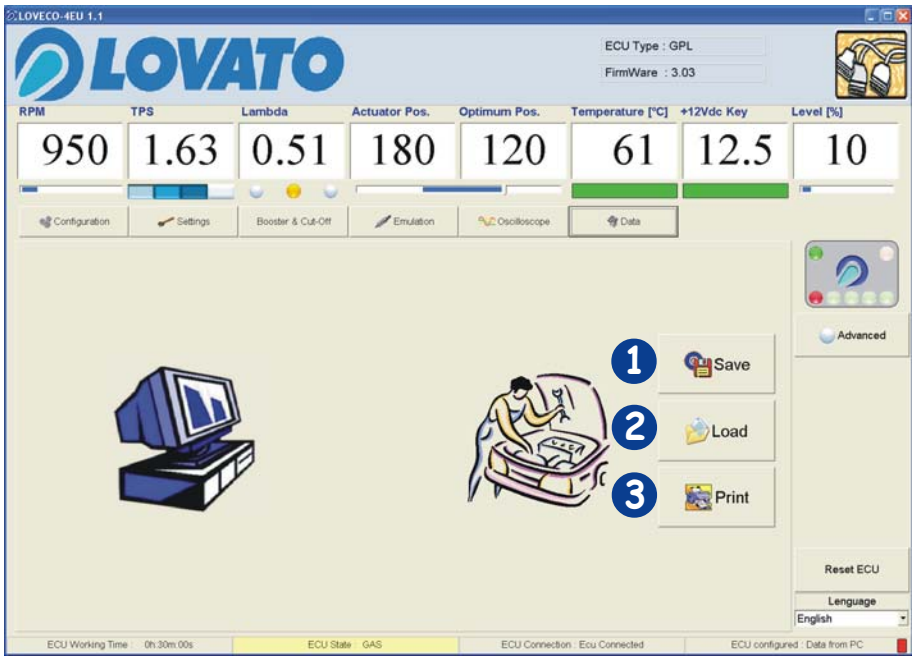


This function displays 4 traces giving information about the duration of the following signals:

1. Lambda probe (Yellow),
2. TPS sensor (Red),
3. Instantaneous position of actuator (Light blue),
4. Optimal position (White),
5. Oxigen sensor emulation (Green).

This window can be very useful when troubleshooting in the gas mode.

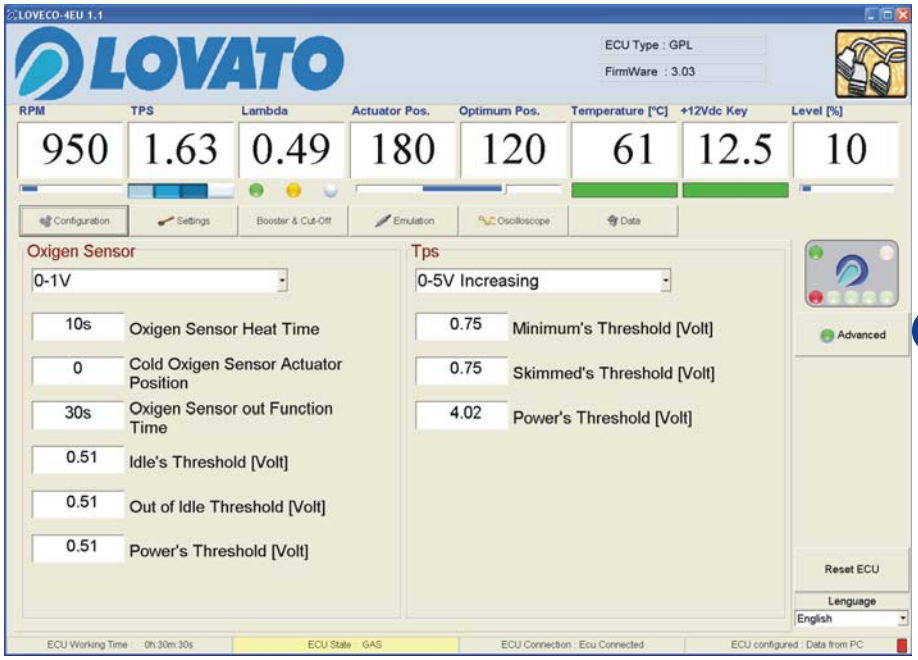
Press the “**Data**” button to open the window for loading/saving the control unit data



1. “**Save**” saves all the control unit data to the computer.
2. “**Load**” loads a set of previously saved parameters to the control unit.
3. “**Print**” produces a text file listing all the parameters set on the control unit.

9.2 Example of Calibration as an expert user and complete description of parameters.

Press the "**Advanced**" (1) button to enter the advanced programming mode. Each window shows additional options or settings that an expert user can use to further refine the calibration of the control unit and improve overall vehicle operation when powered by gas.
The following figure shows the "**Configuration**" window after pressing the "Expert" button.



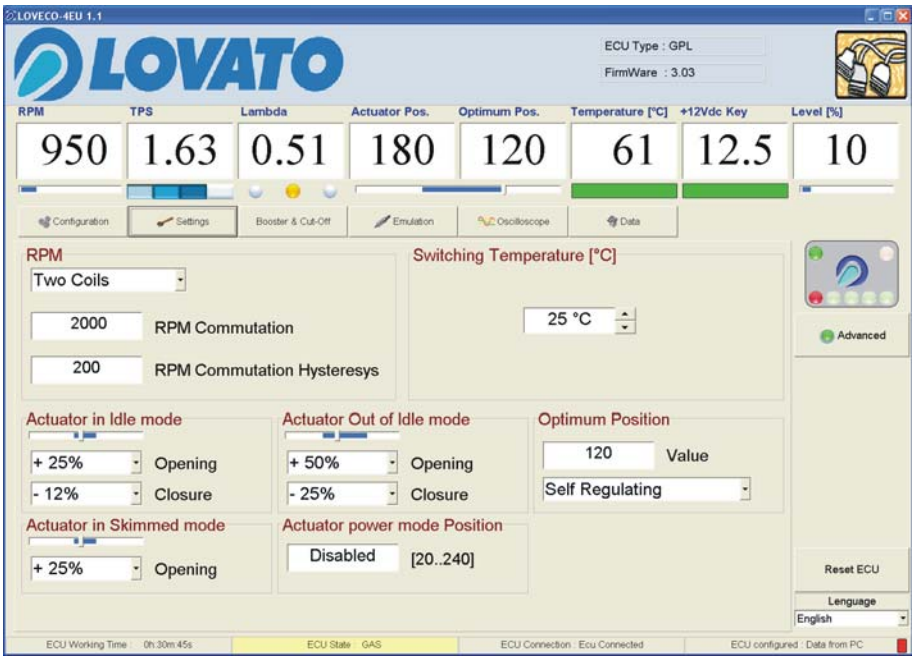
The following parameters appear in the "**Lambda Probe**" box:

- **Faulty probe time**. When the lambda probe is broken (or a wire is cut or disconnected) the signal read by the control unit is constant and no longer significant. This parameter specifies the time that must elapse before the lambda probe is considered faulty. If the lambda probe does not work, the actuator moves to its optimal position. If the lambda probe starts working correctly again, the system resumes normal operation using the feedback signal to adjust the opening and closing of the flow actuator. The default value is 30 seconds. It is not normally necessary to modify this value. Values between 15 and 80s should be used.
- **Idle threshold**. This indicates the lean/rich inversion (and vice-versa) voltage threshold of the lambda probe at idle.
- **Out-of-idle threshold**. This indicates the lean/rich inversion (and vice-versa) voltage threshold of the lambda probe out of idle.
- **Power threshold**. This indicates the lean/rich inversion (and vice-versa) voltage threshold of the lambda probe in the power mode.

The lambda probe inversion thresholds are not normally modified. These values should only be modified if the lambda probe does not work correctly. With a 0-1V lambda probe generating values from 0.3V and 0.9V, it may be useful to slightly increase the three thresholds. The three thresholds should be set to the same value. If the value is too high, the lambda probe always indicates lean and the flow actuator opens to make the Air-Gas mixture richer. On the contrary, if the threshold value is too low, the lambda probe always indicates rich and the stepper motor closes to reduce the quantity of gas sent to the engine.
The following two parameters appear in the **TPS** box:

- **Just-above-idle threshold**. If modified, this parameter must be set at a value greater than or equal to the TPS idle threshold. Before calibration, the two parameters have the same value. If this threshold is modified, a new work area is created. Just-above-idle corresponds to a slight pressure on the accelerator pedal when the idle mode changes to just out of idle. This operating condition is normally ignored and it is not necessary to modify this parameter.
- **Power threshold**. This voltage threshold, higher than all the others, indicates operating conditions when the pedal is pressed fully down.

Press the “**Settings**” button to open the window shown in the following figure.



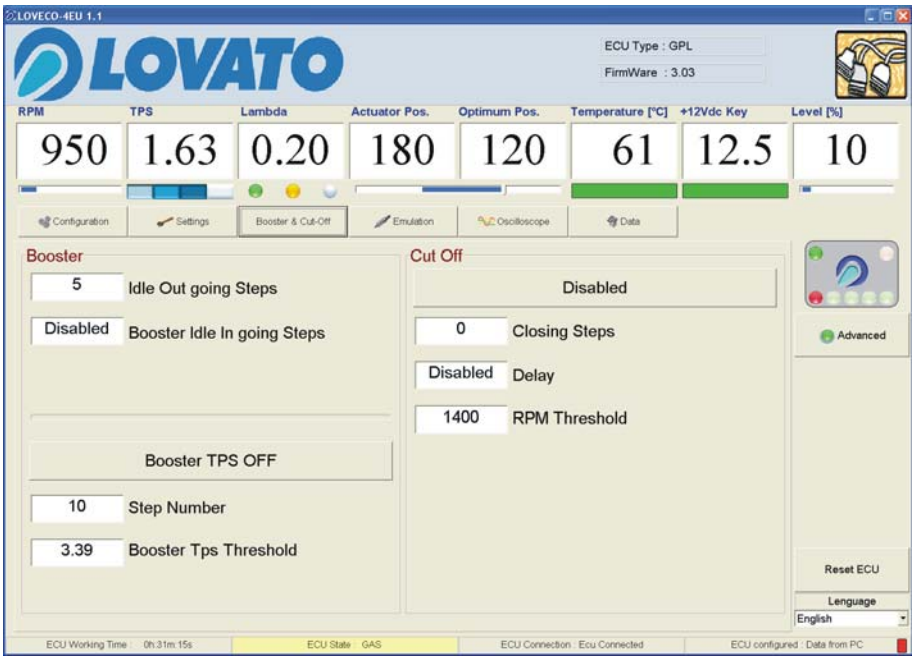
The RPM box contains a new item, “**RPM hysteresis switching**”, and two new boxes appear.

Expert users may the hysteresis on the RPM threshold for switching to gas. To switch to gas, the car must exceed the RPM threshold. After exceeding the threshold, the REVS must decrease by the set hysteresis and allow the car to switch to gas. With Loveco 4EU control units, engine RPM readings have been improved to a definition of less than 50 RPM. The basic value set on the control units is 200 RPM. If this value is changed, it should not fall below 100 RPM.

The maximum just-above-idle opening can be set In the “**Actuator just above idle**” box. The maximum just-above-idle closing is the same as that used in the idle mode. If idle closing is changed, out-of-idle closing must also be modified.

The “**Position of actuator in power mode**” box can be used to set the position that the flow actuator must take when the accelerator pedal is pressed (the TPS signal exceeds the TPS in Power threshold value set in the “Configuration” window). This parameter indicates an absolute position. If this parameter is set to 0, the stepper motor follows the feedback from the lambda probe. If this parameter is set to a value from 20 to 240 steps in the power mode, the stepper motor moves to the specified number of steps without considering the limits set by the maximum closing and opening values.

When accessing the "**Booster & CUT-OFF**" window, the screen shown in the following figure opens.



The only new parameter to appear in this window is the "**RPM Threshold**" inside the "CUT-OFF" box. The Loveco 4EU control unit uses this RPM threshold to establish when to enable CUT-OFF. If the engine works at lower RPM than the set value, CUT-OFF is ignored and the stepper motor does not close the gas flow. If the RPM exceeds the threshold value, the car may enter the cut-off mode. On some cars with particularly low or high idle values, it may be useful to increase or decrease this threshold value.

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